# A DISSERTATION ON
# COMPARATIVE STUDY OF SUBTROCHANTERIC FRACTURES MANAGED BY PROXIMAL FEMUR NAIL AND PROXIMAL FEMUR LOCKING PLATE

Dissertation submitted to

**THE TAMIL NADU DR.MGR.MEDICAL UNIVERSITY**

**CHENNAI – 600032**

In partial fulfilment of the regulations

For the awards of the degree of

**M.S. DEGREE BRANCH – II**

**ORTHOPAEDICS**

**MAY 2018**

**GOVERNMENT MOHAN KUMARAMANGALAM**

**MEDICAL COLLEGE, SALEM**

## *GOVERNMENT MOHAN KUMARAMANGALAM*

## *MEDICAL COLLEGE, SALEM*

## ***DECLARATION BY THE CANDIDATE***

*I solemnly declare that this dissertation* ***"COMPARATIVE STUDY OF FUNCTIONAL OUTCOMES OF SUBTROCHANTERIC FRACTURES MANAGED BY PROXIMAL FEMUR NAIL AND PROXIMAL FEMUR LOCKING PLATE " IN GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM*** *is a bonafide and genuine research work carried out by me under the guidance and supervision of* ***Prof Dr.C.KAMALANATHAN, M.S.(Ortho), DNB, D.(Ortho) Professor and Head of Department,*** *Department of Orthopaedics, Government Mohan Kumaramangalam Medical College Hospital, Salem, Tamil Nadu, India.*

*Place: Salem*

*Date :* 20/10/17

*Signature of the Candidate*

**DR.S.T.SANJU**

**GOVERNMENT MOHAN KUMARAMANGALAM**

**MEDICAL COLLEGE, SALEM**

## CERTIFICATE BY THE GUIDE

*This is to certify that this dissertation entitled "**COMPARATIVE STUDY OF FUNCTIONAL OUTCOMES OF SUBTROCHANTERIC FRACTURES MANAGED BY PROXIMAL FEMUR NAIL AND PROXIMAL FEMUR LOCKING PLATE" IN GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM** is a bonafide work done by **Dr. S.T.SANJU** partial fulfillment of the requirement for the degree of M.S. Orthopaedics, examination to be held in 2018.*

20/10/17

Dr. A.D.SAMPATHKUMAR, M.S.,Ortho
Associate Professor of Orthopedics
Civil Surgeon, Reg. No. 47571
GMKMC & Hospital, Salem-

***Signature of the Guide***

*Place:Salem*

*Date :* 20/10/17

***PROF.DR.A.D.SAMPATHKUMAR***
***M.S, Ortho,***
***Professor of Orthopaedics***
***Govt Mohan Kumaramangalam Medical College, Salem, Tamilnadu***

***GOVERNMENT MOHAN KUMARAMANGALAM***

***MEDICAL COLLEGE, SALEM***

## ***ENDORSEMENT BY THE HEAD OF DEPARTMENT***

*This is to certify that this dissertation entitled "**COMPARATIVE STUDY OF FUNCTIONAL OUTCOMES OF SUBTROCHANTERIC FRACTURES MANAGED BY PROXIMAL FEMUR NAIL AND PROXIMAL FEMUR LOCKING PLATE" IN GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM** is a bonafide work done by **Dr. S.T.SANJU** under overall guidance and supervison **Prof Dr.C.KAMALANATHAN, M.S.(Ortho), DNB, D.(Ortho) Professor and Head of Department,** Department of Orthopaedics, Government Mohan Kumaramangalam Medical College Hospital, in partial fulfillment of the requirement for the degree of M. S. in Orthopaedics, examination to be held in May 2018.*

Head of the Departm
Department of Orthopaed
GMKMCH, SALEM.

*Seal & Signature of the HOD*

***Prof Dr.C.KAMALANATHAN, M.S.(Ortho), DNB, D.(Ortho)***
***Professor & HOD of Orthopaedics,***
***Govt. Mohan Kumaramangalam Medical College, Salem, Tamilnadu***

*Place:Salem*

*Date :* 20/10/17

## *GOVERNMENT MOHAN KUMARAMANGALAM*

## *MEDICAL COLLEGE, SALEM*

SINCERITY SERVICE SALVATION

## ***ENDORSEMENT BY THE DEAN OF THE INSTITUTION***

*This is to certify that this dissertation entitled* ***"COMPARATIVE STUDY OF FUNCTIONAL OUTCOMES OF SUBTROCHANTERIC FRACTURES MANAGED BY PROXIMAL FEMUR NAIL AND PROXIMAL FEMUR LOCKING PLATE" IN GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM*** *is a bonafide work done by* ***Dr. S.T.SANJU*** *under overall guidance and supervison of* ***Prof Dr.C.KAMALANATHAN, M.S.(Ortho), DNB, D.(Ortho) Professor and Head of Department,*** *Department of Orthopaedics, Government Mohan Kumaramangalam Medical College Hospital, in partial fulfillment of the requirement for the degree of M. S. in Orthopaedics, examination to be held in 2018.*

20/x/17

DEAN
Govt. Mohan Kumaramangalam
Medical College Hospital,
Salem - 636 001.

*Seal & Signature of the Dean*

**DEAN**
**Govt. Mohan Kumaramangalam Medical College, Salem, Tamilnadu**

***Place:Salem***

***Date :*** 20/10/17

## GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE & HOSPITAL

# COPYRIGHT



*Signature of the Candidate*

**Dr. S.T.SANJU**

*Date:* 20/10/17

*Place: Salem*

# ACKNLOWDGEMENT

At the outset I thank the Lord, Almighty, for giving me strength to perform all my duties.

It is indeed a great pleasure to recall the people who have helped me a lot in completion of my dissertation. Naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a few, who have helped me in diverse ways.

First & foremost, I would like to thank Dean, **Dr.Kanagaraj M.D**., Government Mohan Kumaramangalam Medical College Hospital, Salem for allowing me to use the available clinical resources and materials of this hospital.

I Acknowledge and express my humble gratitude and sincere thanks to **Prof.Dr.C.KAMALANATHAN M.S.Ortho., DNB Ortho., D.Ortho.,** Professor and HOD, Department of Othopaedics, Government Mohan Kumaramangalam Medical College Hospital, Salem for his constant supervision and help for this study.

It gives me immense pleasure to express my deep sense of gratitude and indebtedness that I feel towards my teacher, inspiration and guide **Prof.Dr.A.D.SAMPATH KUMAR M.S. Ortho.,** Professor Department of Orthopaedics, Government Mohan Kumaramangalam Medical College Hospital, Salem for his valuable suggestions, guidance, great care, motivation, constant encouragement and attention to detail that he has so willingly shown throughout the study which facilitated the completion of this dissertation.

I owe a great deal of respect and gratitude to Professor and unit heads **Prof.Dr.T.M.MANOHAR M.S Ortho,**

**Prof.Dr.R.T.PARTHASARATHY, M.S. Ortho** for their scholarly suggestions and all around encouragement.

I take this opportunity to express my most humble and sincere gratitude to Assistant Professors ***Dr.S.Kumar M.S.Ortho.,***

***Dr.P.Radhakrishnan M.S.Ortho., Dr.S.Jawahar M.S.Ortho.,***

***Dr.R.N.Suresh Kumar M.S.Ortho., Dr.T.Karikalan M.S.Ortho.,***

***Dr.M.Kannan M.S.Ortho., Dr.N.Karthikeyan M.S.Ortho.,***

***Dr.P.Arunanand M.S.Ortho., Dr.Chinnaudrai D.Ortho.,***

***Dr.L.Kumar M.S.Ortho., Dr.S.Selvakumar M.S.Ortho.,***

***Dr.Satish Kumar D.Ortho, DNB Ortho., Dr.T.Senthil Kumar D.Ortho.,***

***Dr.Syed naser M.S.Ortho., and Dr.P.Sivakumar M.S.Ortho.,***

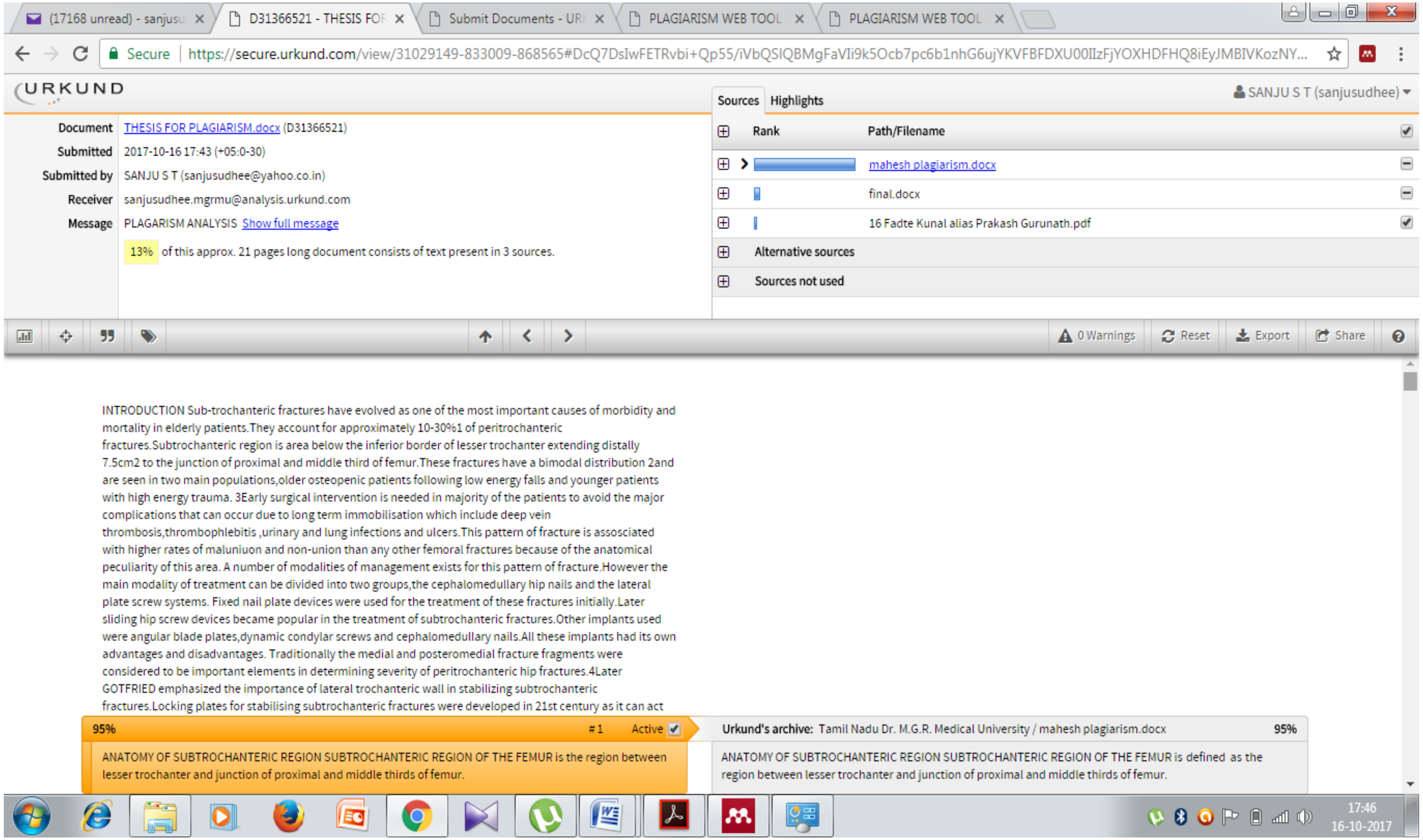
I am also grateful to the Deputy Superintendent and Regional Medical officer of government Mohan Kumaramangalam Medical College Hospital, Salem.

I also take this opportunity to thank the Department of Anaesthesiology and Department of radio diagnostics, Operation Theatre Staff nurses, Non Medical Staff for their continuous support and cooperation.

I would like to make a special mention about **Dr.P.KARTHIKEYAN** for his immiscible support for my thesis work. No amount of words can measure up to the deep sense of gratitude and thankfulness that feel towards my parents and wife for their valuable help, everlasting support and motivation.

My sincere thanks to all my postgraduate juniors for their wholehearted support.

From the bottom of my heart I convey my heartful gratitude to all my parents and their relatives who formed the backbone without whose cooperation this study would have been incomplete.


(17168 unread) - sanjusu
D31366521 - THESIS FOF
Submit Documents - URI
PLAGIARISM WEB TOOL
PLAGIARISM WEB TOOL
Secure | https://secure.urkund.com/view/31029149-833009-868565#DcQ7DsIwFETRvbi+Qp55/iVbQSIQBMgFaVIi9k5Ocb7pc6b1nhG6ujYKVFBFDXU00IIzFjYOXHDFHQ8iEyJMBIVKozNY...
URKUND
Sources Highlights
SANJU S T (sanjusudhee)
Document THESIS FOR PLAGIARISM.docx (D31366521)
Submitted 2017-10-16 17:43 (+05:0-30)
Submitted by SANJU S T (sanjusudhee@yahoo.co.in)
Receiver sanjusudhee.mgrmu@analysis.urkund.com
Message PLAGARISM ANALYSIS Show full message
13% of this approx. 21 pages long document consists of text present in 3 sources.
Rank Path/Filename
mahesh plagiarism.docx
final.docx
16 Fadte Kunal alias Prakash Gurunath.pdf
Alternative sources
Sources not used
0 Warnings Reset Export Share
INTRODUCTION Sub-trochanteric fractures have evolved as one of the most important causes of morbidity and mortality in elderly patients.They account for approximately 10-30%1 of peritrochanteric fractures.Subtrochanteric region is area below the inferior border of lesser trochanter extending distally 7.5cm2 to the junction of proximal and middle third of femur.These fractures have a bimodal distribution 2and are seen in two main populations,older osteopenic patients following low energy falls and younger patients with high energy trauma. 3Early surgical intervention is needed in majority of the patients to avoid the major complications that can occur due to long term immobilisation which include deep vein thrombosis,thrombophlebitis ,urinary and lung infections and ulcers.This pattern of fracture is associated with higher rates of maluniuon and non-union than any other femoral fractures because of the anatomical peculiarity of this area. A number of modalities of management exists for this pattern of fracture.However the main modality of treatment can be divided into two groups,the cephalomedullary hip nails and the lateral plate screw systems. Fixed nail plate devices were used for the treatment of these fractures initially.Later sliding hip screw devices became popular in the treatment of subtrochanteric fractures.Other implants used were angular blade plates,dynamic condylar screws and cephalomedullary nails.All these implants had its own advantages and disadvantages. Traditionally the medial and posteromedial fracture fragments were considered to be important elements in determining severity of peritrochanteric hip fractures.4Later GOTFRIED emphasized the importance of lateral trochanteric wall in stabilizing subtrochanteric fractures.Locking plates for stabilising subtrochanteric fractures were developed in 21st century as it can act
95% #1 Active
ANATOMY OF SUBTROCHANTERIC REGION SUBTROCHANTERIC REGION OF THE FEMUR is the region between lesser trochanter and junction of proximal and middle thirds of femur.
Urkund's archive: Tamil Nadu Dr. M.G.R. Medical University / mahesh plagiarism.docx 95%
ANATOMY OF SUBTROCHANTERIC REGION SUBTROCHANTERIC REGION OF THE FEMUR is defined as the region between lesser trochanter and junction of proximal and middle thirds of femur.
17:46
16-10-2017

Ref. No.6027/MEI/2015

Office of the Dean,
Govt. Mohan Kumaramangalam
Medical College, Salem - 30

Dated.06.01.2016.

Ethical Committee Meeting held on 23.12.2015 at 11.00 A.M in the Seminar Hall, IInd Floor, Medicine Block, Govt. Mohan Kumaramangalam Medical College Hospital, Salem - 01.

| Name of the Presenter with Address | Title | Name of the Guide and Address | Whether it is Approved or not |
|---|---|---|---|
| Dr.S.T.Sanju 1St Year,Post Graduate Student of M.S (Orthopaedics), GMKMC, Salem-30, | Comparative Analysis of functional outcomes of subtrochanteric fractures managed by Proximal femur nail and Proximal lateral femur locking plate | Dr.A.D.Sampath Kumar M.S Associate Professor of Orthopaedics, GMKMC, Salem | Approved |

The Ethical Committee examined the studies in detail and is pleased to accord Ethical Committee approval for the above Post Graduate student of this College to carry out the studies with the following conditions.

1. He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution to Government.

2. He should inform the institution Ethical Committee in case of any change of study procedure site and investigation or guide.

3. He should not deviate from the area of the work for which applied for Ethical clearance. She should inform the IEC immediately, in case of any adverse events or serious adverse reactions.

4. He should abide to the rules and regulations of the Institution.

5. He should complete the work within the specific period and if any extension of time is required she should apply for permission again and do the work.

6. He should submit the summary of the work to the Ethical Committee on completion of the work.

7. He should not claim any funds from the institution while doing the work or on completion.

8. He should understand that the members of IEC have the rights to monitor the work with prior intimation.

06/01/16
DEAN

6/1/16

To
The Individual.

## CONTENTS

**LIST OF FIGURES**

## LIST OF TABLES

## LIST OF CHARTS

# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| 1 | AO | ARBEITSGEMEINSCHAFT FUR OSTEOSYNTHESEFRAGEN |
| 2 | AP | ANTEROPOSTERIOR |
| 3 | DHS | DYNAMIC HIP SCREW |
| 4 | DCS | DYNAMIC CONDYLAR SCREW |
| 5 | ECG | ELECTROCARDIOGRAM |
| 6 | ECHO | ECHOCARDIOGRAPHY |
| 5 | HIV | HUMAN IMMUNODEFECIENCY VIRUS |
| 6 | HCV | HEPATITIS C VIRUS |
| 7 | HBsAg | HEPATITIS B SURFACE ANTIGEN |
| 8 | IV | INTRAVENOUS |
| 9 | IM | INTRAMEDULLARY |
| 10 | P value | PROBABILITY VALUE |
| 11 | PFLCP | PROXIMAL FEMUR LOCKING COMPRESSION PLATE |
| 12 | PFN | PROXIMAL FEMUR NAIL |
| 13 | RTA | ROAD TRAFFIC ACCIDENT |
| 14 | HHS | HARRIS HIP SCORE |

## ABSTRACT

Subtrochanteric fractures are a variant of peritrochanteric fractures of femur extending 5cm distal to the lesser trochanter.Management of subtrochanteric fractures is a major challenge and treatment failure is common for it .

**AIM** : To compare the functional outcomes of subtrochanteric fractures manged by Proximal femur nail and Proximal femur locking plate.

**MATERIALS AND METHODS**: This is a prospective study of 20 cases of subtrochanteric fractures admitted in Govt Mohan Kumarangalam Medical College Hospital, Salem during the period from December 2015 to September 2017.The cases were classified under Russel Taylor classification.Out of the 20 cases 10 cases were managed by Proximal femur nail and 10 cases were managed by Proximal femur locking plate.

**RESULTS**: In our study, we observed that there were significant reduction in operating time(p value:0.001) and decrease in blood loss (p value:0.000) in cases managed by PFN when compared to PFLCP.Among the cases managed by PFN closed nailing was done in 50% of cases whereas open reduction was required in all cases managed by PFLCP which was a significant difference (p value:0.033). Among the cases managed by proximal femur all cases united except for one case which went for hypertrophic non union. One case had breakage of the nail distal to the lag screw and one case had breakage of derotation screw. Among the cases managed by PFLCP,3 cases went for non union with implant failure , one among these 3 cases revision surgery was done with PFN.

**CONCLUSION**: Even though both PFN and PFLCP are effective in the treatment of subtrochanteric fractures,  we observed that PFN was a better implant than PFLCP, because PFN enables more of a biological fixation with less disturbance of fracture haematoma, faster than PFLCP and lesser amount of blood loss.

Keywords:Subtrochanteric fractures,Proximal femur Nail,Proximal femur locking compression plate.

## AIM OF THE STUDY

The aim of the study is to do a comparative analysis of the functional outcome of subtrochanteric fractures managed with ‘PROXIMAL FEMORAL NAIL’and PROXIMAL FEMUR LOCKING COMPRESSION PLATE at Government Mohan Kumaramangalam medical college hospital, Salem between December 2015 to August 2017.

# INTRODUCTION

Sub-trochanteric fractures have evolved as one of the most important causes of morbidity and mortality in elderly patients.They account for approximately 10-30%[1] of peritrochanteric fractures.Subtrochanteric region is area below the inferior border of lesser trochanter extending distally 5 cm[2] to the junction of proximal and middle third of femur.These fractures have a bimodal distribution [2]and are seen in two main populations, older osteopenic patients following low energy falls and younger patients with high energy trauma.

[3]Early surgical intervention is needed in majority of the patients to avoid the major complications that can occur due to long term immobilisation which include deep vein thrombosis, thrombophlebitis, urinary and lung infections and ulcers. This pattern of fracture is assosciated with higher rates of maluniuon and non-union than any other femoral fractures because of the anatomical peculiarity of this area.

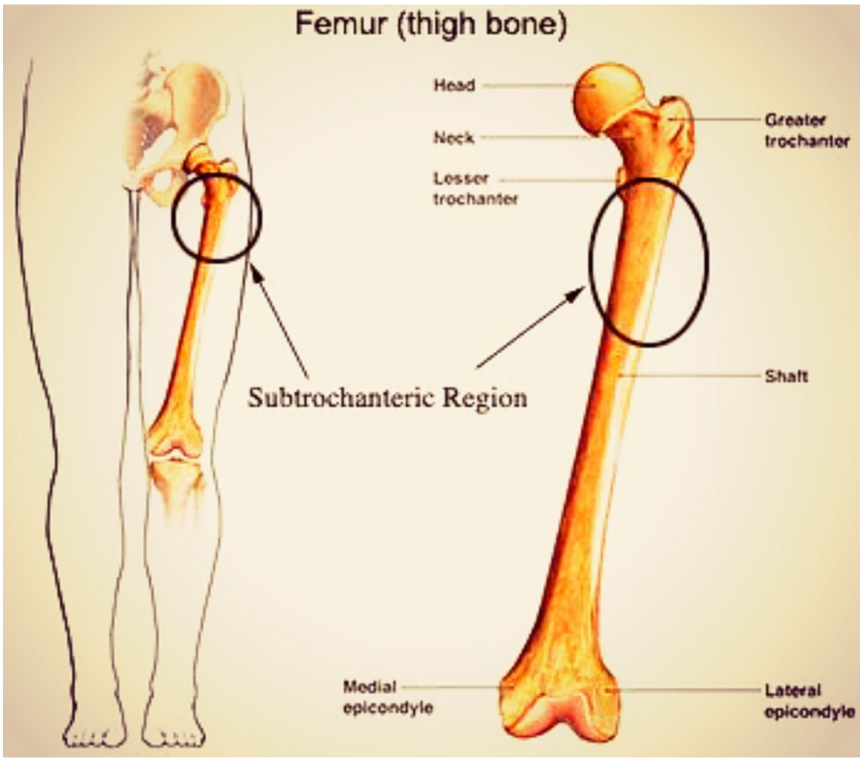
A number of modalities of management exists for this pattern of fracture. However the main modality of treatment can be divided into two groups, the cephalomedullary hip nails and the lateral plate screw systems.

Fixed nail plate devices were used for the treatment of these fractures initially. Later sliding hip screw devices became popular in the treatment of subtrochanteric fractures. Other implants used were angular blade plates,dynamic condylar screws and cephalomedullary nails. All these implants had its own advantages and disadvantages.

Traditionally the medial and posteromedial fracture fragments were considered to be important elements in determining severity of peritrochanteric hip fractures.[4]Later GOTFRIED emphasized the importance of lateral trochanteric wall in stabilizing subtrochanteric fractures.Locking plates for stabilising subtrochanteric fractures were developed in 21$^{st}$ century as it can act as a buttress for the lateral trochanteric wall and helps in the stabilisation of lateral trochanteric wall.

## ANATOMY

SUBTROCHANTERIC REGION OF THE FEMUR is the region between lesser trochanter and junction of proximal and middle thirds of femur. It is defined as a zone extending from the lesser trochanter of the femur to 5cm distal to the lesser trochanter. This area is subjected to higher stresses and compressive forces anatomically. Anatomically this part of the femur is prone for non union and slow healing. Due to the predominance of cortical bone in this area and decreased vascularity to the cortical bone,healing capacity is impaired. A large amount of significant weight transmission occurs to this area even with normal day to day activities.[5]About 6 times the body weight of a person is transmitted to the subtrochanteric area during normal activities of daily life.



## MUSCULAR ATTACHMENTS

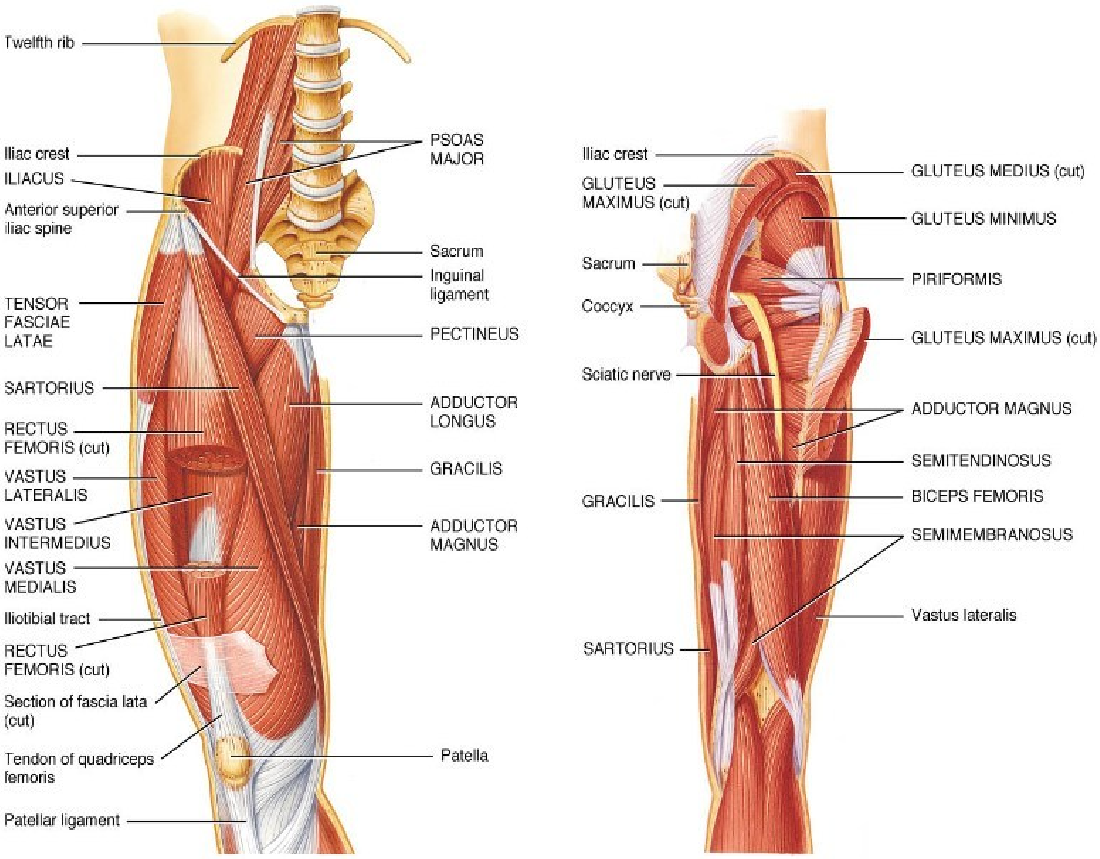
Subtrochanteric region of femur is covered by various muscle groups. Anteriorly and laterally muscular attachments includes vastus medialis,vastus intermedius and vastus lateralis. and medially by adductor brevis and adductor longus . Deforming forces in subtrochanteric fractures are due to the various muscular attachments to the proximal and distal fragments.

These include the abductors attached to the greater trochanter. Gluteus medius orginates from the gluteal surface of illium between the middle and posterior gluteal lines and gets attached to the greater trochanter.

Gluteus minimus is the other main muscle which gets attached to the anterior surface of greater trochanter. It arises under the cover of gluteus medius from the gluteal surface of illium between the middle and inferior lines. Both these muscles are supplied by superior gluteal nerve and they abduct the proximal fragment.

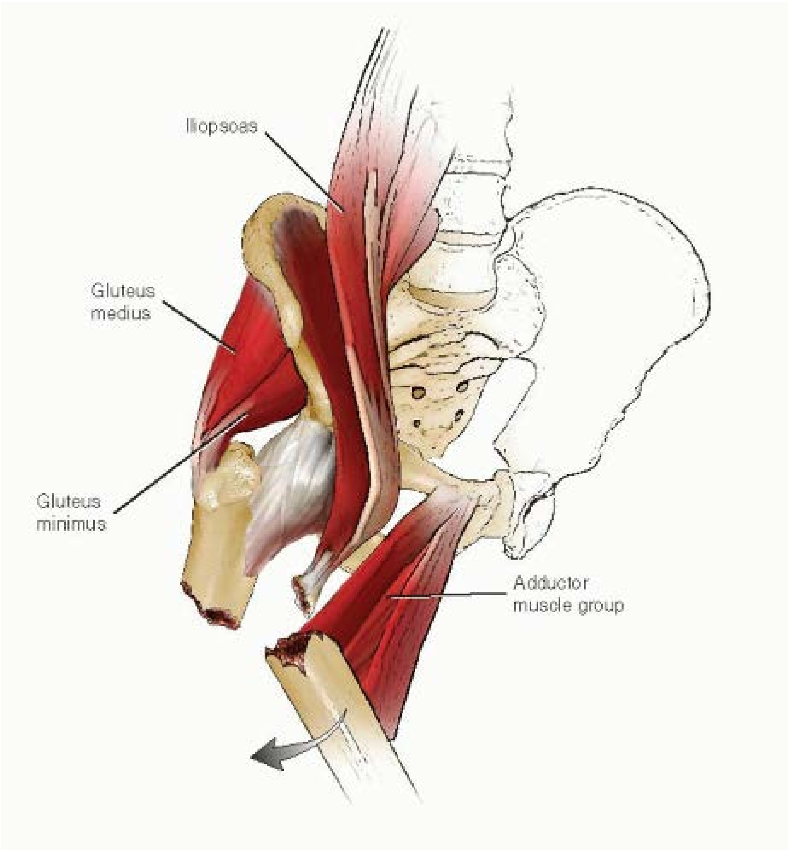
Iliopsoas muscle typically causes the proximal fragment to flex. Illiacus along with the psoas tendon forms a powerful flexor of the hip joint. Illiacus muscle arises from the iliac fossa it blends alongs with the rounded psoas tendon ,psoas muscle arises from the lumbar spine and both gets inserted to the lesser trochanter. Thus illliopsoas acts as a powerful flexor of hip joint.Glutei muscles and illiopsoas will abduct and flex the proximal fragment in subtrochanteric fractures

Distal fragment because of the unopposed pull from the adductor magnus, always displaces it medially and further aggravates the deformity. Adductor magnus is a composite muscle mass formed by the fusion of adductors along with the hamstring muscles. Hamstrings orginate from the ischial tuberosity and the fibres vertically downwards get attached to the adductor tubercle. Adductor group of muscles constitute the adductor longus and the adductor brevis. Adductor longus is the most superficial of all the three adductors which arises from a circular area on the body of pubis by a strong rounded tendon,this tendon may sometimes get ossified , known as rider's bone. It gets attached into the middle third of the linea aspera of femur. Adductor brevis arises from the body and inferior ramus of the pubic bone and is insertred in a triangular fashion into the upper part of linea aspera immediately behind the insertion of pectineus and adductor longus.




(a) Anterior superficial view

(b) Posterior superficial view



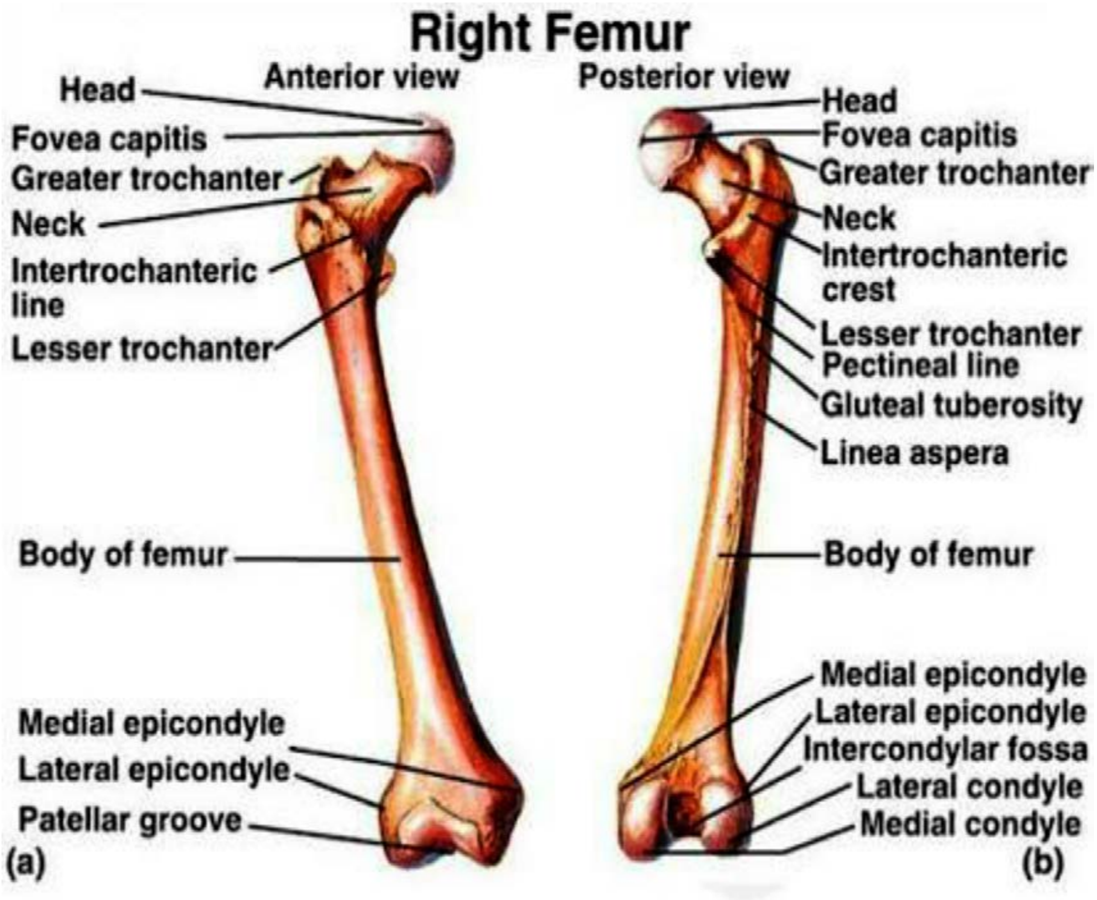
## PARTS OF PROXIMAL FEMUR

**GREATER TROCHANTER:** It is a type of traction apophysis, a bony quadrangular prominence at the junction of upper part of neck and shaft. Muscular attachements to the greater trochanter are Gluteus medius, Gluteus minimus, Pyriformis.

Obturator internus along with Superior and Inferior Gemelli form a common tendon which gets inserted into the medial aspect of the greater trochanter. Obturator externus gets inserted into the trochanteric fossa .

**PYRIFORMIS FOSSA:** It is a depression situsted just medial to the greater trochanter which forms the entry point for intra medullary nailing.

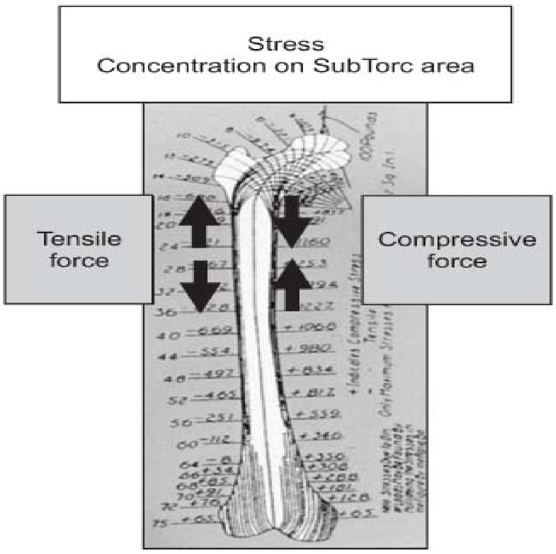
**LESSER TROCHANTER**: It is a small bony protuberance from the posteromedial aspect of femur.The apex of lesser trochanter has three borders and provides attachment for Psoas major and illiacus. Psoas major is inserted into the apex of trochanter and Illiacus is inserted into the base of lesser trochanter.


Right Femur
Anterior view
Posterior view
Head
Fovea capitis
Greater trochanter
Neck
Intertrochanteric line
Lesser trochanter
Body of femur
Medial epicondyle
Lateral epicondyle
Patellar groove
(a)
Head
Fovea capitis
Greater trochanter
Neck
Intertrochanteric crest
Lesser trochanter
Pectineal line
Gluteal tuberosity
Linea aspera
Body of femur
Medial epicondyle
Lateral epicondyle
Intercondylar fossa
Lateral condyle
Medial condyle
(b)

## BIOMECHANICS

Forces applied to the hip during ambulation produces stresses in the proximal femur due to the combined effects of axial, bending and torsional loads.[3]Major compressive stresses in the femur are greatest in the medial cortex 5 -7cm below the lesser trochanter, i.e. the subtrochanteric region and this region is considered to be one of the highly stressed areas in the body.[4] Tensile stresses of about 25% less occur at the lateral cortex slightly proximally. Following a subtrochanteric fracture, deforming muscle forces play a vital role in causing malunion and produce difficulty in achieving union.Typically the proximal fragment undergoes flexion, abduction and external rotation due to the unopposed pull by the glutei muscles which gets attached to the greater trochanter, the illiopsoas attached to the lesser trochanter will produce flexion of the proximal fragment. The short external rotators are responsible for the external rotation of the proximal fragment. Distal fragment because of the unopposed pull from the adductor magnus, always displaces it medially and further aggravates the deformity, hamstring muscles are responsible for shortening of the distal fragment. In addition comminution of the medial cortex further adds to the injury. In addition comminution of the medial cortex further adds to the insult of this highly stressed area. Higher forces are generated with eccentrically placed devices such as plates and screws as compared to the centromedullary devices

There are [6,7]four main factors affecting the healing process in subtrochanteric fractures, the first and the foremost important factor is the high stress in the subtrochanteric region, especially in the posteromedial cortex.[8],[9]Frankel and Burstein showed that the hip joint reaction forces reaches almost 3 times the body weight upon muscle contraction. Second the abundant large amount of cortical bone hinders the healing process because of the decreased vascularity to the cortical bone when compared to cancellous bone. Furthermore stripping of the muscles and soft tissue damage occurring during surgical procedure will further devascularise the area. Thirdly,[7]Fromison described the concept of deforming forces in the subtrochanteric area as a factor for slow healing of subtrochanteric fractures. Lastly the union can be accelerated by keeping the fractured bone segments stationary relative to each other and allowing some micromotion




Cephalomedullary nails are able to provide necessary bending and torsional stability to combat the displacement of the fracture fragments. Proximal femoral nail being an intra medullary device is a load sharing device and has the inherent advantage of shorter lever arm, thereby decreasing the tensile strain on the implant. The hip screw and the anti rotational screw proximally provide increased rotational stability of the head-neck fragment. The two distal locking screws control the rotational stability of the distal fragment.  A biomechanical analysis by[10] **TENCER etal** on various implants used for subtrochanteric fracture have found that bending stress, torsional stress, load to axial failure are superior in cephalomedullary implants than all the other implants. Another biomechanical evaluation done by[11] **PAUL R.T. KUZYK etal** in 2009, on reverse oblique trochanteric fractures concluded that intramedullary devices were significantly stiffer and had a greater load to failure than the 135 degree and 95 degree constructs, especially with a gap between the bony fragments. Indirect fracture reduction, preserving the fracture hematoma, less soft tissue dissection, decreased amount of blood loss add to the decreased overall morbidity[7,12].PAJARINEN etal reported a series of 103 subtrochanteric fractures treated with PFN and concluded that those patients treated with PFN could weight bear earlier and take functional recovery training earlier when compared to other surgical modalities. It also better prevents the varus collapse of medial cortex of subtrochanteric region and is highly useful in fractures with medial comminution.In cases of posteromedial comminution or breakage of the medial cortex ,extramedullary devices tend to fail and intramedullary implants form the better option for treatment.

Proximal femur LCP is anatomically pre contoured plate to the subtrochanteric region,Biomechanical analysis by[1] BRETT D CHRIST et all comparing locking plates with angled blade plates showed on bone models showed PFLCP has high axial load stiffness,in their study they concluded that PFLCP with kickstand screw was the stiffest construct.Precontoured anatomical structure can prevent varus collapse and malreduction by contouring the tip of the plate with the tip of greater trochanter.Also the presence of three proximal locking screws into the neck of the femur helps to maintain or restore the neck shaft angle relationship. The three proximal screws adds to the increased pull out strength and are most effective in osteoporotic bones. Morover this plate acts as an internal external fixator and allows some amount of elasticity across the fracture site which enhances callus formation by secondary bone healing. Meta analysis by [13]Parker and Handoll in their study concluded that intramedullary nails was not superior to extramedullary device.[3,14]The lateral wall is also an important stabilising factor in subtrochanteric fractures was first reported by Gotfried. It plays a key role in stabilisation and fixation of subtrochanteric fractures. While using cephalomedullary hip nails, an intact lateral wall is a must in case of subtrochanteric fractures.[3]On reaming fractures with ruptured lateral wall reaming of proximal femur would cause distraction of the fragments and peritrochanteric instability, so in cases of ruptured lateral trochanteric wall, proximal femur locking plates acts as a good alternative method of fixation. However open reduction of the fractured fragments can cause increased blood loss, increase in the operating time and devascularisation of the fractured fragments.

## CLASSIFICATION

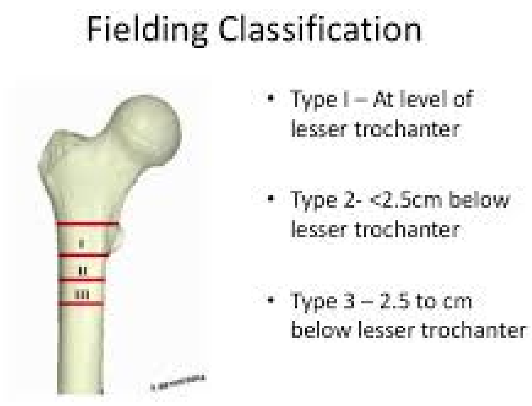
Subtrochanteric fractures were initially grouped under comminuted intertrochanteric factures.[15] Boyd and Griffin initially considered them as a variant of intertrochanteric fractures. At least 15 different classification systems has been devised for subtrochanteric fractures. Out of them most widely used classification systems are the Russel and Taylor Classification, Fielding Classification, Seinsheimer and AO classification.

1. **FIELDING AND MAGLIATO** Devised a three part anatomical classification in 1966.

**TYPE 1:** Fracture at the level of lesser trochanter

**TYPE 2:** Fracture within 1 inch below lesser trochanter

**TYPE 3:** Fracture within 1 to 2 inches below lesser trochanter



**2. RUSSEL TAYLOR classification :** This classification is based on current techniques and principals of closed intramedullary nailing and continuity of lesser trochanter and extension of fracture lines into greater trochanter (or) posteriorly into pyriform fossa. It disregards the degree of comminution.

**TypeI:** Fracture does not extend into pyriform fossa.

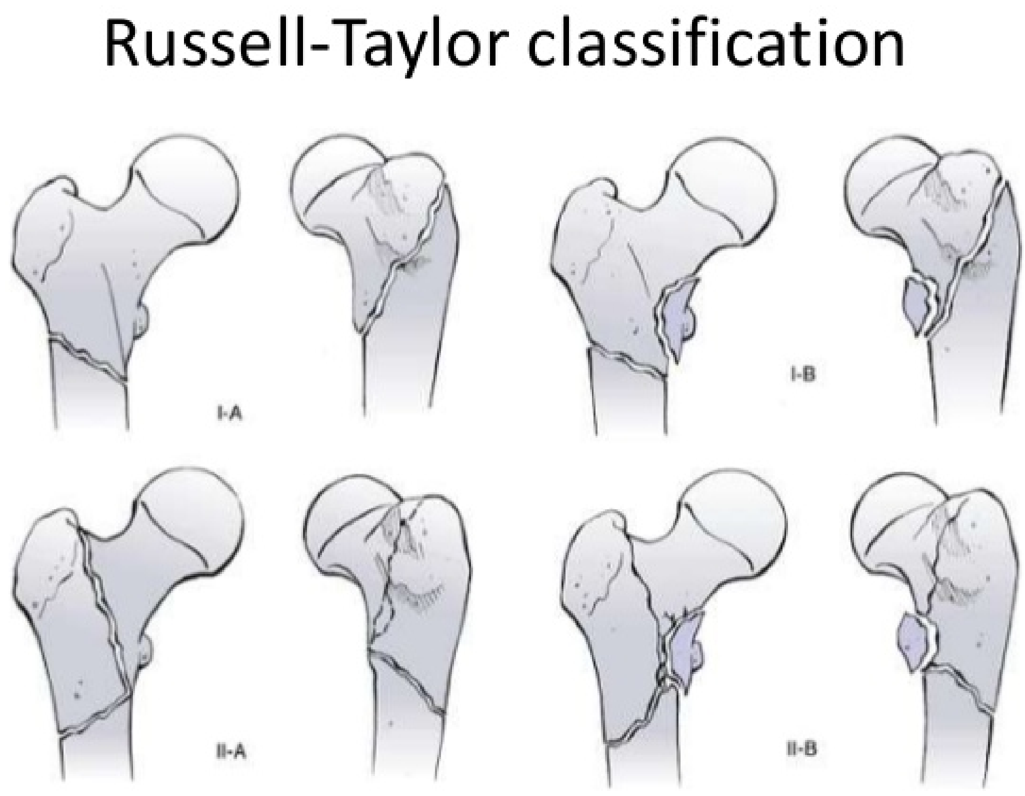
**TypeIA:** Comminution and fracture line extend from below lesser trochanter to femoral isthmus

**TypeIB**: Fracture line and comminution involve area of lesser trochanter to isthmus.

**TypeII:** Fracture extends into Pyriform fossa.

**TypeIIA**. No significant comminution (or) fracture of lesser trochanter is seen. **TypeIIB.**Comminution of medial cortex and loss of continuity

According to the Russel and Taylor Classification,initially for Type I fractures where the pyriformis fossa is not involved can be treated with Ist generation intramedullary nails and for Type II fractures extramedullary implants are used.But with the development of newer generation nails, this classification system has lost its popularity and importance.




**3.** In 1978 [16]**SEINSHEIMER** developed a classification based on fracture pattern. Significance of this classification is that it identified fractures with loss of medial cortex stability, which is known to have a higher rate of implant failure

**TYPE I:** Undisplaced (or) Less than 2mm displacement

**TYPE II:** Two Part Fracture.

**TYPE IIA.** Transverse fracture

**TYPE IIB**. Spiral Fracture with lesser trochanter attached to proximal fragment.

**TYPE IIC.** Spiral Fracture with lesser trochanter attached to distal fragment

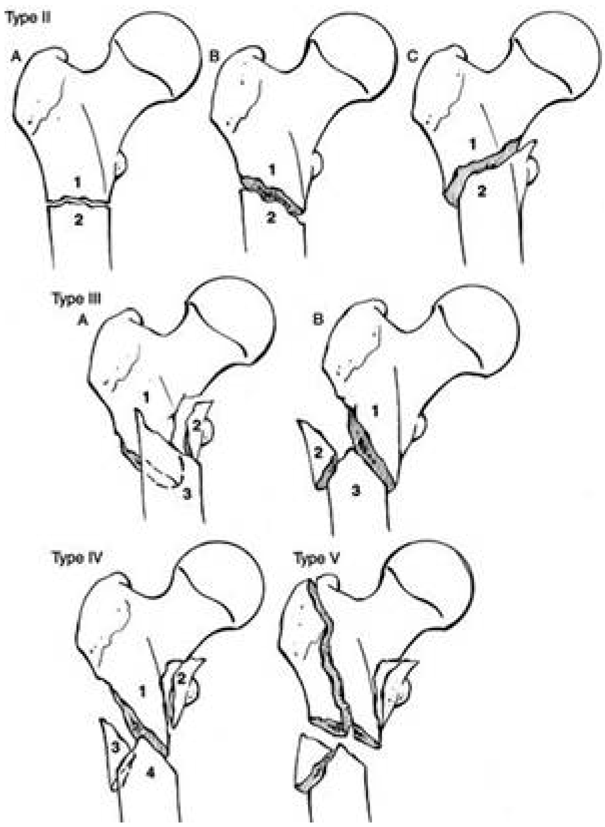
**TYPE III:** Three Part Fracture.

**TYPE IIIA**: Three part spiral fracture with lesser trochanter as a part of third fragment.

**TYPE IIIB:** Three part spiral fracture with third part a butterfly fragment.

**TypeIV:** Comminuted fracture with four (or) more fragments

**TypeV:** Subtrochanteric-Intertrochanteric configuration.




[17]Recently a new classification system was proposed by Guyver et al and was divided into 3 types:

Type I: Lesser and greater trochanter are preserved.

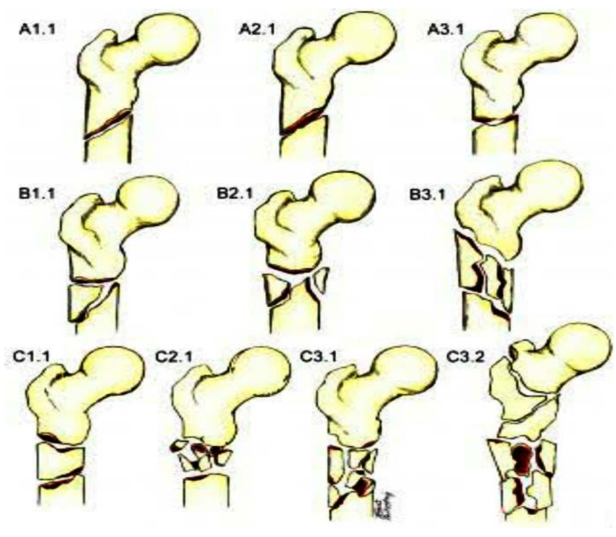
Type II: Greater trochanter is involved but lesser trochanter is intact.

Type III: Lesser trochanter is involved and is highly unstable.

AO Classification system is now the widely used and accepted universal classification system.

This classification takes into account the bone,(femur-3),the location(diaphysis-2),the energy of trauma (A,B,C) and the mechanism (1,2,or 3).The subtrochanteric fractures are categorised as 1.

Disadvantage of this system is including subtrochanteric fractures under diaphyseal fractures.



## MANAGEMENT

At present the management of subtrochanteric fractures in adults is entirely surgical. Previously many non surgical methods was used. In the late 1960's cast bracing was used, traction followed by bracing with hip spica cast was another modality ,but due to increased morbidity of prolonged bed rest caused in elderly people non operative treatment methods have been abandoned.

CONSERVATIVE METHODS: [15]Till date there has been no comprehensive randomised controlled trials comparing the conservative and operative management.[18]Parker and colleagues in their study observed a fixation failure rate of 12% in 103 patients where 93 patients underwent operative treament

1. SKELETAL TRACTION: In subtrochanteric fractures larger weights are used in skeletal traction as compared to trochanteric fractures because of the larger deforming forces.Under radiographic control adjustments are made in traction until we obtain a satisfactory reduction in both anteroposterior and lateral views.[15]Varus or valgus angulation of less than 5 degrees,at least 25% opposition of fracture fragments in both planes and shortening of less than 1cm are aimed for.Traction can be

continued for 8-12 weeks until there is evidence of radiological union.Patient is then mobilised ,in non weight bearing walking.In a study conducted, [15]Velasco and Comfort found that satisfactory results was found in only 50% of 32 cases treated conservatively.Perkins traction was found to be advantageous as it prevents quadriceps atrophy.[15,19]Wadell observed that 10 satisfactory and 8 unsatisfactory results and found 90 – 90 traction superior than Thomas splint traction.

2.CAST BRACING: A report on external support by hip spica or cast brace with a pelvic extension splint has been described.[15]15 subtrochanteric fractures were managed with a 90-90 traction followed by traction using bracing with hinged knee single[20] hip spica cast

3.PINS IN PLASTERS:[15,21]In this technique 2 pins are inserted above the fracture and 2 pins are inserted below the fracture and incorporating them in plaster.Full weight bearing was allowed.[22]Seligson and Harman in 6 patients found problems like shortening, angulation and malrotation

4. EXTERNAL FIXATION:[20]External fixation was first described for trochanteric fractures by Anderson,however it was assosciated with problems like pin tract infection and non –union.Even with the use of

modern external fixators full weight bearing is not possible,but it may be of use in the case of open subtrochanteric fractures.

OPERATIVE MANAGEMENT: Implant used for fixation of subtrochanteric fractures can be broadly divided into intramedullary and extramedullary implants.

EXTRAMEDULLARY IMPLANTS:

1. Dynamic Hip Screw: DHS has been widely used in the management of subtrochanteric fractures.Numerous studies have been done using DHS as a mode of fixation. [23]In a study conducted in King Saud University of Saudi Arabia,where DHS was used in 24 patients with comminuted subtrochanteric fractures union was achieved in 19 patient within a span of 18 weeks.[15]However we require an anatomic reduction,stable fixation and reconstruction of medial cortex is important for a favourable outcome in DHS.[20]Radford and co-workers reported 64% good results in 11 patients
2. Dynamic Condylar Screw:[24]Dynamic condylar screw has been a favourable implant for subtrochanteric fractures.It exerts a vertical forces on weight bearing and is a better option as it provides a stronger fixation in the cancellous bones of head and neck with considerable rotational stability.

3. 95 Degrees angled blade plate:It has been the gold standard for the treatment of subtrochanteric fractures.Many comparative prospective randomised controlled trials between DCS and angled blade plate has been conducted.[24]A research article has recently been published in March 2017 in the International Journal of Research in medical sciences where DCS and angled blade plate was compared in subtrochanteric fractures .The study was conducted in Rajindra Hospital Patiala Punjab and in their study they concludedthat DCS is superior to angled blade plate.The main limitations of angled blade plate is the extensive lateral approach required for the plate insertion and devascularisation of fracture fragments due to extensile exposure.

4. MEDOFF AXIAL COMPRESSION SCREW:It has been recently used for the management of subtrochateric fractures.[25]Mainly recommended for transverse subtrochanteric fractures with or without reverse obliquity.It is recommened to use uniaxial dynamization in pure subtrochanteric fractures and we can use staged biaxial dynamization for intertrochantric fractures with extension into subtrochanteric area.[26]It is a highly technically demanding procedure

5.PROXIMAL FEMUR LCP: [27]Anatomically pre contored angular stable plate for the proximal metaphseal region of femur.This plate was developed as it acts as a stabilising factor for [27,28]lateral trochanteric wall and as a stress shield prevents lateral migration of proximal fragments.[27,29]It is an implant of choice for transverse subtrochanteric fractures with ruptured lateral trochanteric wall

6.DISTAL FEMUR LCP: Opposite side distal femur LCP is a less invasive locking plate system used recently .[30]Biomechanically sound implant its shape fits well with contour of greater trochanter and shaft fits well with the anterolateral curve of femur.Advantages include preservation of periosteal blood supply and no need of image intensifier.

INTRAMEDULLARY INPLANTS:

1.INTERLOCKING NAIL: [31]Hey-Groves first reported IM nailing of subtrochanteric fractures .This modality of treatment has been recommended for simple subtrochanteric fractures where there is no trochanteric extension.[15]To date the most effective is Russel Taylor Reconstruction nail. Various interlocking nail used were:

a) KAMPALA OR HUCKSTEP NAIL

b) KUNTSCHNER NAIL

c) RUSSEL TAYLOR IM NAIL

d) AO FEMORAL NAIL

e) DERBY IM NAIL

f) ZIMMER RECONSTRUCTION NAIL

2.ZICKEL NAIL: One of the first intramedullary implant to give consistently good results with high union rate.[31]Removal of the nail following fracture union is one of the major problems concerned with the nail and refracture is a recognized complication.

3.ENDERS NAIL: This nail has been mainly used for low energy fractures with minimal comminution. Usually open reduction and internal fixation supplemented with cerclage wiring is recommended.[31]Levy and colleagues reported a high prevelance of post operative knee pain.

4.GAMMA NAIL: [31]This nail has been encountered with many complications including intra-operative and post-operative femoral shaft fractures due to three point loading on trochanter and femoral corticres.

5.PROXIMAL FEMUR NAIL: [4]Advantages of PFN includes the shorter lever arm ,load sharing device producing less stress on implant,introduction without exposing fracture site,transmits weight close to calcar,distal locking screw provides length and rotational control permits early weight bearing.It also causes less soft tissue damage and devascularisation of the fracture fragments.

## REVIEW OF LITERATURE

Subtrochanteric fractures were treated conservatively in 1902 by [32]HIBBS in a position of flexion, abduction and external rotation by bringing distal fragment into alignment with the proximal fragment.[32]In 1960 , Sarimento introduced the concept of femoral cast bracing for the conservative management of subtrochanteric fractures[32]. Mooney also did the same in 1975 and this was regarded as a poor modality of treatment with respect to varus angulation.[33]SEINSCHEIMER in 1978 advocated conservative management of subtrochanteric fractures due to higher rate of complications assosciated with operative management of subtrochanteric fractures.[3332]DE LEE in 1981 reported excellent results with 90-90 traction followed by hip spica immobilisation and recommended this for patients with inoperable and open fractures. Traction as a mode of treatment in subtrochanteric fractures was analysed by [33]WADELL since the deforming forces was well dissipiated in this modality of treatment.

Operative treatment of subtrochanteric fractures was made as early as in 1910 by [33]DELBET with a thick screw with higher pitch that had a better purchase into the bone.[33] In1947 CLEVELAND and in 1951 EVANS used plate Moore Bount plate ,NEUFLED plate and Lorenzo screw respectively.Clover leaf nail was popularised by KUNTSCHNER in 1942 for the treatment of subtrochanteric fractures.BOYD AND GRIFFIN, KRIK WATSON and CAMPBELL popilarised the use of JEWETT nail in 1940's and 1950's.Due to the high failure rates with Jewett nail as observed by FELDING and MAGILATO the usage of this nails decresed.This led to the development of newly designed angled plates with a "U" profile and fixed angles of 95 degrees and 135 degrees by AO group.[33i]In 1971 Arnoff,in 1972 Distefano in 1974 Cech and Felding widely used these plates and it led to higher rates of complications like varus, rotational deformities, non-union, implant failure and medialisation of distal fragment.[34]In late 1970's and in 1978 HANDSON and TULLOS used the AO blade plates which became a popular device for subtrochanteric fractures.Sliding hip screw for subtrochanteric fractures was used by WADELL in 1979.Later in 1992 SCHLEMINGER, CLAWSON and MASSIE popularised the use of DHS designed by AO/ASIF group as they noted 32% complications with the AO blade plate.Zickel in 1966 introduced intramedullary device with an inbuilt screw and it provided excellent strength with good control of varus and rotation of proximal fragment, but the implant failed due to rotational control over distal fragment as there was no facility for distal locking. From early 1980's closed nailing techniques started gaining importance and this techniques has shown higher rates of union and lower rate of infections. Russel Taylor introduced in late 1980's intramedullary interlocking nail and in 1990 [35]HALDER introduced Gamma nail.

Proximal femur nail was introduced in 1997 by AO /ASIF group to overcome all implant related complications. An increased stability and a significant reduction of distal stress was observed by HUBER SM,HEINING SMR,EULER.E. [36]SIMMERMACHER RK, BOSCH in 1999 and A HERRERA in their respective studies on PFN showed relatively low percentage of complications and low incidences of implant failure as compared to Gamma nail .SUDAN M SADOSWIKI in their prospective randomized study on 206 patients compared DHS with PFN and stated the advantages of this intramedullary nail .CHRISTIAN BOLDIAN 1 year later showed that PFN is suitable for unstable subtrochanteric fractures .In 2005 DANIEL F.A suggested PFN was a very good implant for management of subtrochanteric fractures because of the lower rate of shaft fractures and also low rates of failure in fixation assosciated with this implant.WOOKIE MIN et al in 2007 had done a comparative study on PFN and Gamma nail for reverse oblique trochanteric fractures and observed that results was biomechanically better with PFN in terms of less liding of lag screw and less changes of neck shaft angle.MSG BALLAL in 2008 observed that with good reduction and minimal dissection,use of appropriate length of nail and proper positioning of implant are necessary in order to avoid revision and to decrease the failure rates.Development of LCP and studies on general principles for clinical uses of LCP start as early as 2003 by WAGNER M on his studies showed that locking screws in the locking plate minimises the compressive forces exerted by the plate on the bone.In 2004,Egol KA,KUBAIKEN et al concluded that locked plates and conventional plates rely on completely different mechanical principles of fracture fixation.In 2008 SCHMIDT ANDREW H showed that anatomically precontoured locking plates revolutionised the treatment of many fractures.In 2009,Mc GREGORY,BJ LUCAS R conducted a comparative study demonstrated that proximal femur locking plate was the stiffest construct[37].In 2010,KIMJW,OH,CW,BYUN YS conducted a study where biomechanical testing of comminuted subtrochanteric fractures proved that Proximal femur LCP is a stronger construct.

## PROXIMAL FEMUR LOCKING COMPRESSION PLATE

PF-LCP is a part of the LCP periarticular plating system,which merges locking screw technology with conventional plating techniques.The LCP has Combi holes in the plate shaft a dynamic compression unit hole with a threaded locking hole.It is a limited contact stainless steel plate.The proximal portion of the plate is precontoured for the proximal femur[38].Plate was first developed in 2007 by AO group in West Chester,USA.

## FEATURES

Anatomically contoured to approximate the lateral aspect of the proximal femur. Plates specifically designed for left or right femurs to accommodate average femoral neck anteversion.[39]The three proximal holes are at the following angles to the plate shaft:

First proximal hole ,95 degrees

Second proximal hole,120 degrees

Third proximal hole,135 degrees

## PROXIMAL SCREWS

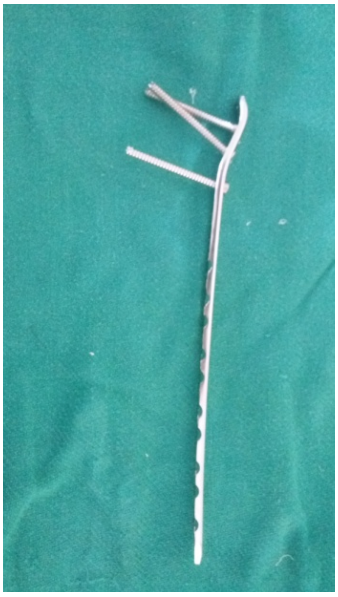
The 2 proximal plate holes are threaded and accept 7.3mm cannulated screws.The third locking hole is threaded to accept 5.0mm cannulated locking screws.[40]Necessity of this screw is fracture configuration dependent and should be identified during preoperative planning.[41]The third screw at 135 degrees is known as[2,4243] kickstand screw and it enhances the stability of the construct .The stability of fixation increases with the application of[40,44] kick stand screw.For better results with PFLCP all the three proximal screws along with the kickstand screw must be applied .[2,43,45]Kickstand screw plays an important role in preventing varus collapse of the construct.

**DISTAL SCREWS**

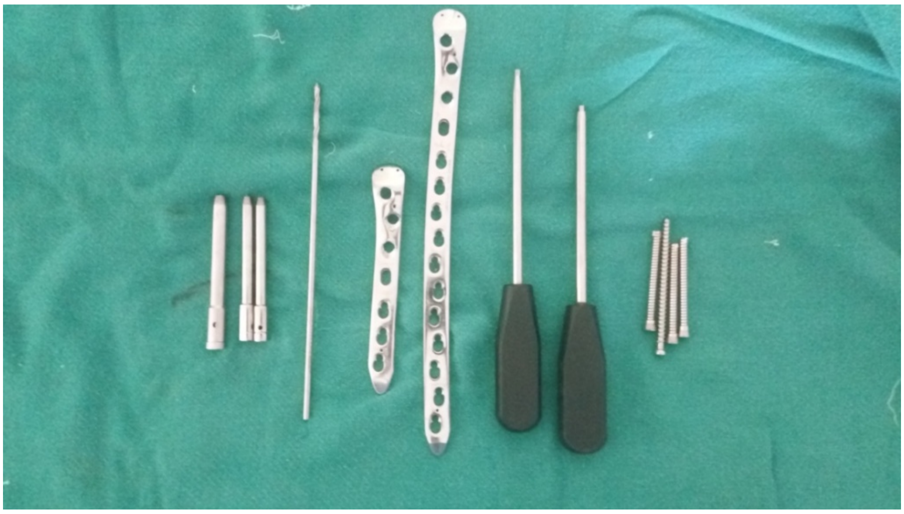
Holes in the shaft of the plate are Combi holes.These holes accept 4.0mm or 5.0mm locking screws in the threaded portion of the hole and 4.5mm cortex screws in the DCU portion.Use of the locking screws provide the option of an angularly stable construct independent of bone quality.

[46]PF-LCP acts as  a fixed angle internal fixator device and is more stable when compared to other implants like DHS/DCS./Angled blade plate.The multiple and various angles at which the screw is inserted enhances the mechanical stability.The 120-135 degree screw provides calcar stability and alo maintains neckshaft angle.

Usually in unstable fractures of proximal femur,lateral trochaneric wall is emerging as an important stabilising factor.The PF-LCP is an ideal implant for these cases as it can act as a[2] buttress for the lateral trochanteric wall as well as acts as stress shield . [47]In cases of fractures where there is no lateral trochanteric wall no lag screw can be applied and cephallomedullary devices are contraindicated. [14]PFLCP is indicated in subtrochanteric fractures where use of intramedullary implant is precluded ,by distal implants,in revision surgeries after corrective osteotomies of malunions and non unions of proximal femur.



PROXIMAL FEMUR LCP WITH SCREWS AT ANGLES OF 95 ,120 AND 135 DEGREES



PROXIMAL FEMUR LCP INSTRUMENTATION

# PROXIMAL FEMUR NAIL

[48]A proximal femoral nail was designed by AO – ASIF group in 1997 for the treatment of proximal femoral fractures. PFN being an intramedullary nail is positioned closer to the mechanical axis of femur and therefore is subjected to less bending moment when compated to laterally placed plate and screw devices.[36] The short lever arm lowers tensile strain on the implant there by reducing risk of implant failure. Additional anti rotational screw will increase the stability of head and neck fragment. The nail can be inserted percutaneously. It has the facility of static or dynamic locking distally. The nail is tapered towards the end to minimize the risk of postoperative fracture at the nail tip and also the distal locking screws are placed more proximally, to avoid abrupt changes in stiffness of the construct. [48,49]This nail has only 6º mediolateral angle which not only makes insertion of the nail easier but decreases chances of intraoperative fracture

## COMPONENTS OF PROXIMAL FEMORAL NAIL

The proximal diameter of nail is 15mm which accomodates wide medullary canal of proximal femur and distal end of the nail is tapered to 9 – 12 mm . The mediolateral inclination is 6 degrees. The proximal part of nail above the mediolateral angular bend has two holes for insertion of neck screw and anti rotational screw. The distal end of the nail has two holes for insertion of interlocking screws. The upper hole is a static hole and lower hole is a dynamic hole which allows dynamization up to 5mm. The nail is available in angles of 130 degrees 135 degrees to match with various femoral neck – shaft angles and diameters of 9,10,11,12 mm sizes and the length of nail varies in sizes from 36cm to 42 cm. The proximal end of the nail also has threads for insertion of end cap which prevents in growth of bone into the nail.

**FEMORAL NECK SCREW**

This is an 8.0mm screw which bears and gives main stability in the proximal fragment for fracture fixation the screw is available in lengths from 70-110mm.

**ANTI ROTATION HIP SCREW**

This is a 6.4 mm stabilization screw, provides the rotational stability for the proximal fragment and the screw is available in lengths from 70-110mm.

**DISTAL LOCKING SCREWS :**

These are 4.9 mm screws inter locking screws.

**COMPONENTS OF PROXIMAL FEMORAL NAIL SYSTEM**

**1.INSERTION HANDLE**

It helps in the insertion of nail along with conical locking bolt and locking nut. The lugs on the handle should engage the positioning notches at the upper end of nail for insertion. It is used for insertion of proximal neck screws and distal locking screws. The holes in the insertion handle position the locking instruments.

2.**THREADED CONICAL BOLT**

The threaded bolt is screwed by hand into the nail and assembled with insertion handle. Once the lugs of the handle have engaged in notches, firm tightening is box spanner

3.**DRIVING PIECE AND DRIVING HEAD**

These are used for insertion of nail with a hammer. Driving piece is screwed onto the threaded conical bolt and driving head is screwed onto the proximal end of the driving piece for insertion with a hammer. The hole in the neck of the driving head allows insertion of Tommy bar

**4.LOCKING INSTRUMENTS**

**a.PROTECTION SLEEVES**

These sleeves should be inserted through the zig for proximal neck screws and distal locking screws to guide for insertion of screws.

**b.DRILL SLEEVES**

These drill sleeves accept 6.5mm / 5.0mm drill bits

**c.TROCAR : 8.0mm**

This trocar is used with 11mm / 8mm protection sleeves for insertion through

**d.DRILL BITS:** 6.5mm, 5.0mm, and 4.0mm.

The 6.5 mm drill bit and 5.0mm drill bit are used to drill holes for 8.0mm femoral neck screw and 6.4 mm anti rotation hip screw respectively. These two drill bits are cannulated for drilling over a guide wire and are marked to know the length of screws to be inserted. The 4.0mm drill bit is used to drill hole for 4.9mm distal locking bolts.

**e.DEPTH GAUZE FOR LOCKING BOLTS**

This depth gauze measures up to 115mm. It has a long neck allowing measuring for locking bolts through distal locking holes in insertion handle.

**f.HEXAGONAL SCREW DRIVER**

This large hexagonal screw driver is used for insertion of 8.0mm femoral neck screw, 6.4mm anti rotational hip screw and 4.9mm distal locking bolts.




# MATERIALS AND METHODS

The study was conducted in 20 patients with subtrochanteric fractures admitted in the emergency department.Out of the 20 cases,10 cases were treated by Proximal femur nail and 10 cases were treated by Proximal femur locking compression plate.The duration of study was from December 2015 to September 2017

## INCLUSION CRITERIA

**1.** Patients admitted in our hospital with subtrochanteric fractures

**2.** Skeletally mature patients.

**3.** Injury within 2 weeks.

## EXCLUSION CRITERIA

**1.** Patients with pathological subtrochanteric fractures.

**2.** Patients in whom surgery was contraindicated due to systemic diseases.

**3.** Immature Skeleton.

**4.** Open fractures.

**5.** Injury more than 3 weeks

The cases were studied on the basis of the mechanism of injury,classification and their functional outcomes were assessed with or without residual complications.

**Emergency Management**

Cases were admitted in the emergency department .

Airway , Breathing , Circulation were assessed .

Life threatening injuries immediately assessed.

Blood transfusion was given

Monitoring of all vital parameters

All other vital organs and associated injuries were examined and managed.

IV analgesics were given.

Patient was immobilised with skeletal traction if there was no contraindications

**PRE OPERATIVE MANAGEMENT**

All routine investigations were done

- Random blood sugar level
- Hemoglobin level
- Bleeding time, clotting time
- Blood grouping, Rh typing
- HIV, HCV , HbSAg
- Serum urea , creatinine
- Serum electrolytes
- Chest Xray

- ECG

Cardiology opinion and ECHO was taken for relevant cases.

For all other co morbid conditions physician fitness was obtained.In our study, one patient had chest wall injury,2 patients had diabetes and one patient had hypertension

## OPERATIVE PROCEDURE- PFLCP

### POSITIONING

Position of the patient is a crucial factor in subtrochanteric fractures.Patient is positioned in supine position in fracture table.Traction is given and satisfactory reduction and alignment is obtained and verified under C –arm guidance.Patient can also be positioned laterally.

### APPROACH

[27,44]Lateral approach is widely used approach,if good satisfactory reduction is obtained and displacement is minimal ,MIPPO technique is used.Length of the incision varies accrding to the fracture pattern.A lateral longitudinal incision of about 10-15 cm is made from 2 cm below the tip of the greater trochanter.After the longitudinal incision of the skin and subcutaneous tissues,the fascia of the vastus lateralis muscle is split at its proximal insertion and the muscle is flipped to visualise the lateral aspect of proximal femur.

### REDUCTION

Fracture is successfully reduced mostly by open reduction,using bone holding forceps and collinear reducion clamps,and we must check for reduction in both AP and lateral views under fluoroscopy.[14]After successfull reduction of the fracture the plate is placed on the lateral aspect of proximal femur.Plate was temporarily fixed to the shaft using K wires and both alignment and reduction of plate is checked under AP and lateral views.Using C arm guidance 3.2mm guide wires were inserted into the proximal hooded position. The position of guide wires are checked in both AP and lateral views.The most distal screw of the proximal hooded portion was first inserted to maintain the femoral neck shaft angle.After ensuring correct position of the guide wires,they were removed and drill bit was inserted through the drill sleeve and screws of adequate length inserted in order to ensure that the screws have a satisfactory subchondral purchase.[46]The position and length of all screws is further rechecked under image intensifier in both AP and lateral views.The plate is then fixed to the distal shaft with minimum cortical screws of 4.5mm (6 cortical purchases)

OPERATIVE TECHNIQUE

TEMPORARY FIXATION

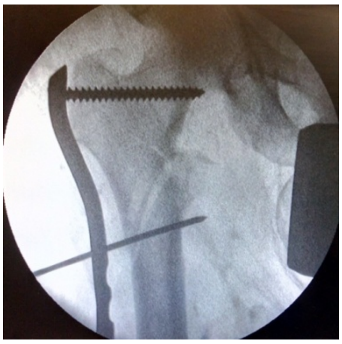
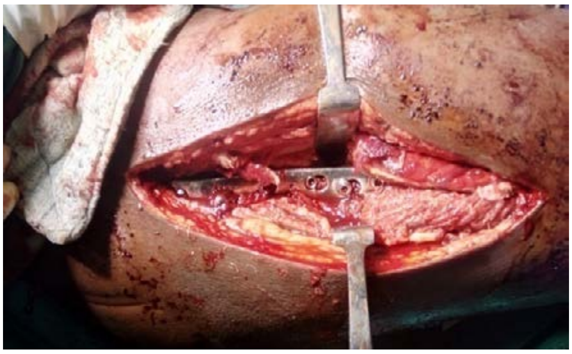


PLATE POSITIONING AND PROXIMAL SCREW



DISTAL SCREW FIXATION WITH PLATE APPLICATION

FINAL C ARM IMAGE

## OPERATIVE PROCEDURE –PFN

### PATIENT POSITIONING

Supine on fracture table will allow good radiological evaluation and better manipulation of leg with application of traction. The body is positioned at an angle of 15 degrees inclination towards the normal side. The normal limb is flexed , abducted and externally rotated for providing enough space thereby helps in positioning of the image intensifier. [32]The affected lower limb is held in traction and adduction attached to the foot piece. Reduction is achieved by traction(disengaging fracture fragments) and internally rotating the limb while maintaining traction and confirmed with image intensifier.If reduction cannot be achieved by closed means the fracture site has to be opened using lateral approach,an anaotomic reduction of the fragments is achieved using bone clamps,K wires and then the nailing is done.

### APPROACH

A 3cm incision made from the proximal tip of greater trochanter slightly bent dorsally. Subcutaneous tissue and deep fascia is incised along the lines of skin incision. Gluteus maximus split by blunt dissection. [32]The tip of trochanter is palpated using finger for making the entry point.This approach is made use in case of closed reductions of fractures.In case of open reduction of subtrochanteric fractures ,the lateral approach is used for reduction of the fracture.

**REDUCTION TECHNIQUES:** If reduction cannot be achieved by closed methods,then other techniques are attempted,this includes methods[50] like depression of proximal fragment with the help of a mallet externally.This method not very effective due to the shortness of the proximal fragment.Insertion of Schanz screw into one of the proximal fragments,is another method,other methods are usage of a bone hook,use of collinear clamps and reduction clamps after opening the fracture site.[51]Another method of reduction of subtrochanteric fractures is by making a small incision using lateral approach and a finger is inserted to reduce the fracture fragments and the nail is then inserted.Clamp assisted reduction technique was developed by[52] Afsari A et al where bone clamps were inserted through the lateral approach and fracture was well reduced using clamps and supplemented by cerclage wiring showed better results.

**ENTRY POINT**

Reduction of the fracture is an essential pre-requisite for determining the entry point.Once the reduction is found to be satisfactory under C arm guidance the entry point is made.[50]The entry point is tip of trochanter or just medial to the tip of greater trochanter, If the reduction is not obtained by longitudinal traction and internal rotation alone we have to use K wire and Steinman pin for temporarily holding the reduction in such a way that it does not interfere in the trajectory of the nail . By confirming the entry point in AP and lateral view, the awl is driven upto the level of lesser trochanter

**GUIDE WIRE INSERTION AND REAMING**

A 3.2mm guide wire is inserted through the entry point and is driven distally. Proximal reaming is done with the help of a 15mm cannulated awl by passing along the guide wire to accommodate the proximal part of the nail which is wider when compared to its distal part. Distal reaming sequentially done 1mm more than the desired diameter of the nail.During reaming protection sleeves can be used in order to prevent soft tissue injuries. After passing guide wire, the position of guide wire is checked under the fluoroscopic guidance in order to ensure that the position of guide wire is central,this will avoid unnecessary eccentric reaming and other deformities.The guide wire is inserted upto 5mm proximal to the intercondylar notch.The guide wire is then gently tapped into the bone to obtain a purchase in the bone which will prevent in advertent guide wire displacement on removal and exchange of the reamers.

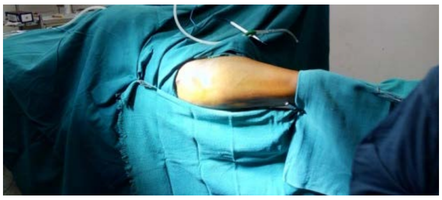
**NAIL INSERTION** The nail which closely matches to the neck shaft angle of the unaffected hip is assembled in the zig. The nail is inserted over the zig and negotiated through the entry point distally by gentle twisting hand movement.If there is difficulty in negotiating the nail,gentle blows are given on the nail with a mallet or further reaming is done. The mounted PFN of appropriate width is further passed distally to the medullary canal to accommodate the proximal two screws into the neck of femur

**PROXIMAL TARGETING**

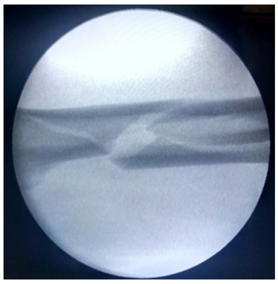
The nail with the zig is checked for alignment of proximal and distal targeting guide to the corresponding holes in the nail before insertion . Through a stab incision made along the lateral aspect of the shaft drill sleeves are inserted into the proximal targeting guide upto the lateral cortex,then the trocar is inserted through the drill sleeve. Guide wires for lag screw and derotation screw is passed through guide pin sleeves upto 5 mm from the articular surface of the femoral head.The position of guide wires are checked under fluroscopic guidance,the guide wire for lag screw should be inferior to the neck in AP view and passing through the central in lateral view. With the help of a cannulated drill bit,dilling is done and the length of the lag screw and derotation screw are checked with the depth gauze and appropriate length lag screw and derotation screw are inserted. The length of derotation screw should be 10 to 15mm smaller than that of the lag screw to avoid 'Z' effect.

**DISTAL TARGETING** :Distal targeting is done with distal targeting guide and drill sleeves using 4.0mm drill bit in cases of short PFN. In case of long nail, distal locking is done through free hand technique under C arm guidance.

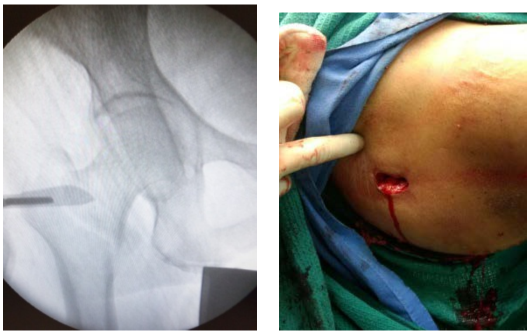
# OPERATIVE TECHNIQUE



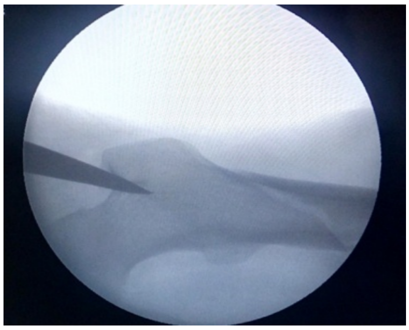
POSITIONING



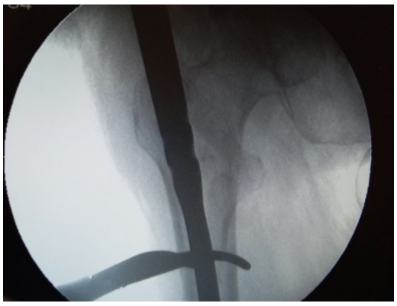
C ARM IMAGE



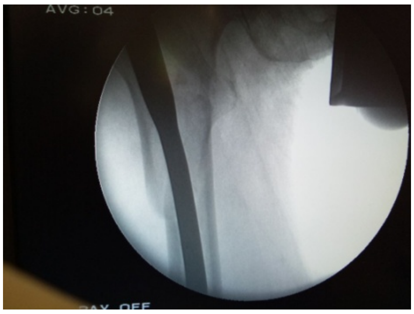
INCISION



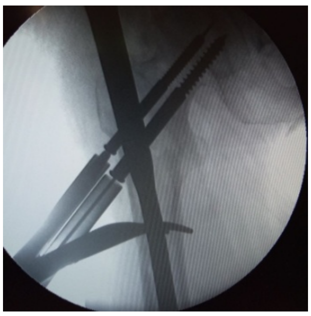
ENTRY POINT



REDUCTION




NAIL INSERTION



PROXIMAL SCREWS

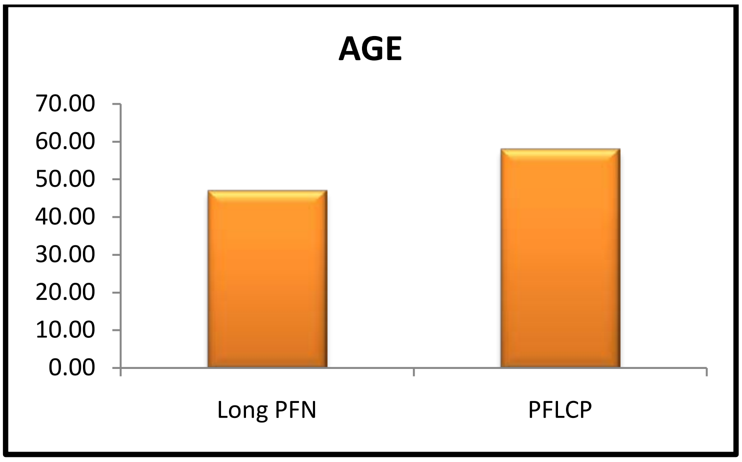
DISTAL LOCKING BOLTS

## POST OPERATIVE MANAGEMENT

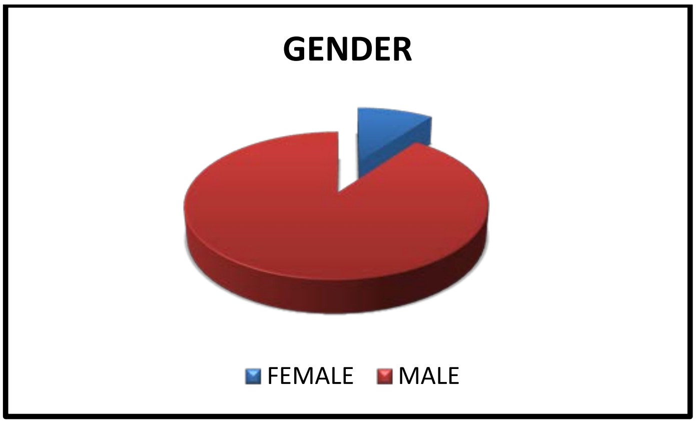
Post operatively patient was managed with IV third generation cephalosporin and aminoglycosides .Oral antibiotics started from $7^{th}$ day onwards.Parentral analgesics were given for the first 2 days depending upon the tolerance level of pain by the patient.Drain was removed on $2^{nd}$ day.Static and quadriceps strengthening exercises and physiotherapy started on $2^{nd}$ day.Nonweight-bearing walking was started on $3^{rd}$ day with walker for cases managed by PFN.In cases of PFLCP weight bearing was delayed upto 8 weeks depending on the evidence of callus formation.Sutures removed on 12 th postoperative day.Radiological evaluation was done on $8^{th}$ week and then every month until evidence of union followed by at 6months and 1 year.Further weight bearing and rehabilitation of the patients were decided based on radiological evidence of callus formation and union. The patients were evaluated with Harris Hip Score at the end of 6 months . In our study of 20 patients 1 patient had chest wall injury,2 patients had diabetes mellitus, one patient in PFN group and one patient in PFLCP group,1 patients in PFLCP group had hypertension,none of the patients had major cardiac disorders.

# OBSERVATION AND RESULTS

In our study the average age of patients where PFN was used was found to be 47 and average age of patients where PFLCP used was 58.




Among our 20 patients in the study 18 patients were males and 2 patients were females.

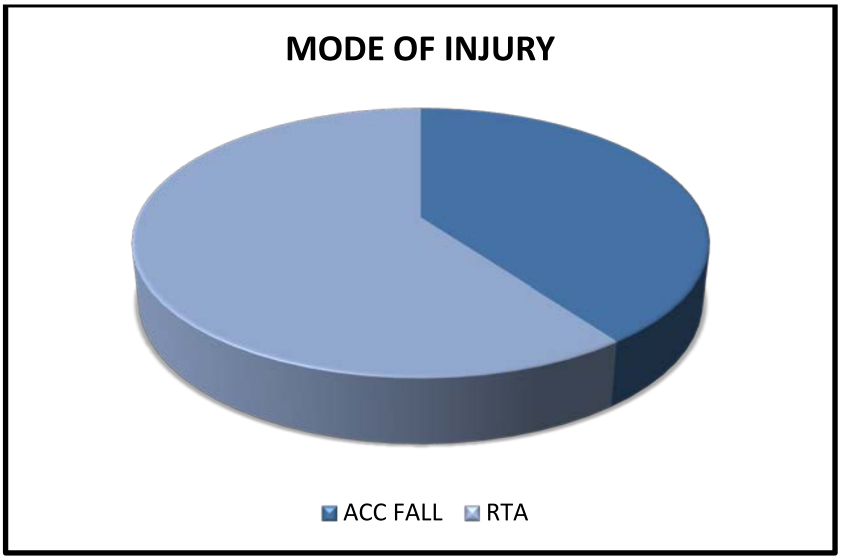



Out of the 10 cases of PFN all patients were males and among the 10 cases of PFLCP only 2 were females

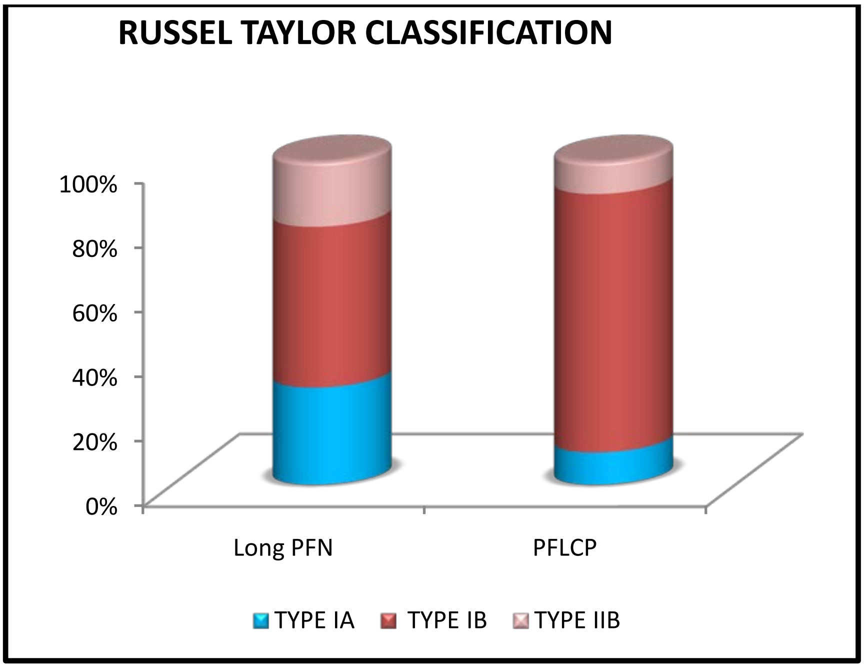
**Crosstab**

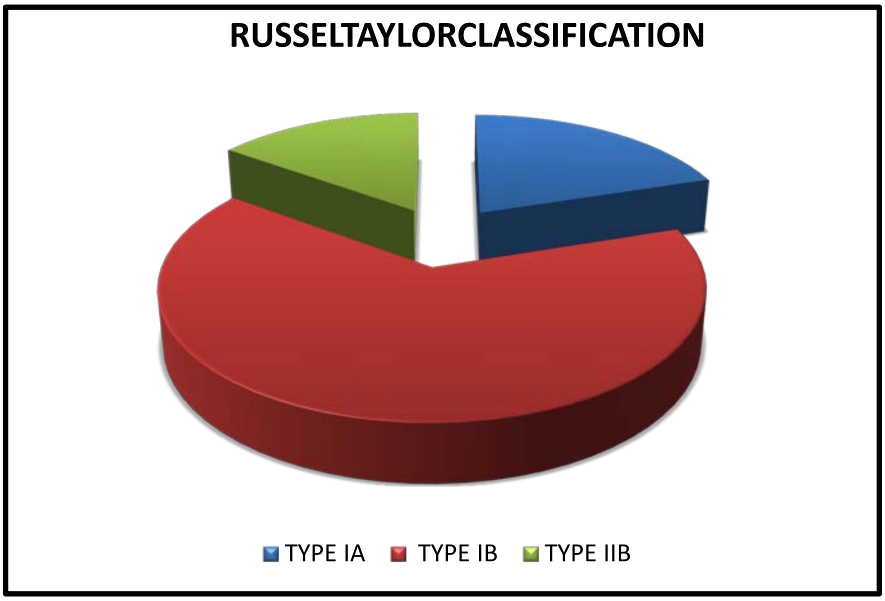
| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| SEX | F | Count | 0 | 2 | 2 |
| | | % within Groups | 0.0% | 20.0% | 10.0% |
| | M | Count | 10 | 8 | 18 |
| | | % within Groups | 100.0% | 80.0% | 90.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

In our study we found that among 20 cases 8 cases were following accidental fall and 12 cases were due to RTA.



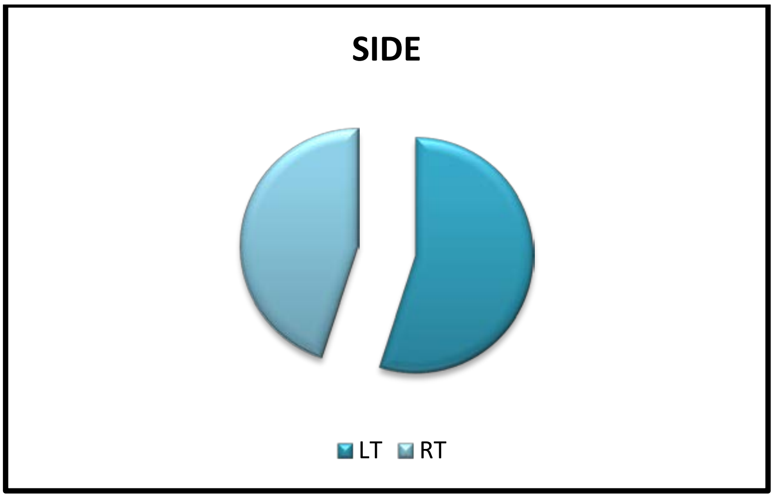

In our study most of the cases were Russel Taylor Type IB.3 cases each were classified under Russel Taylor type IIB and 4 cases were classified under type IA.



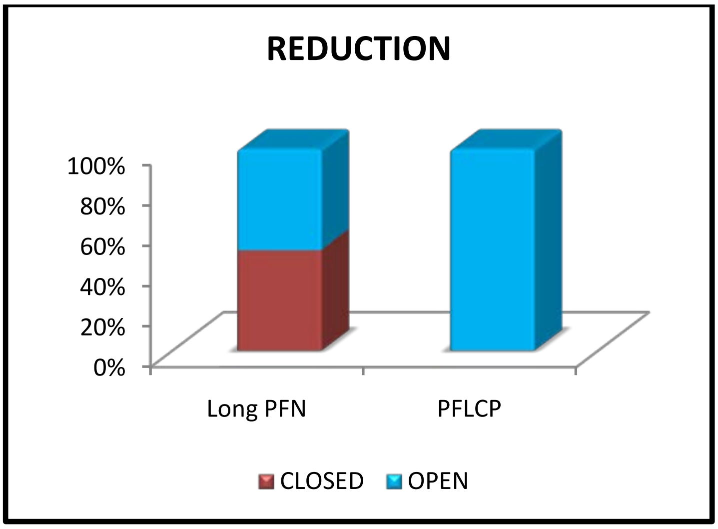

| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| RUSSELTAYLORCLASSIFICATION | TYPE IA | Count | 3 | 1 | 4 |
| | | % within Groups | 30.0% | 10.0% | 20.0% |
| | TYPE IB | Count | 5 | 8 | 13 |
| | | % within Groups | 50.0% | 80.0% | 65.0% |
| | TYPE IIB | Count | 2 | 1 | 3 |
| | | % within Groups | 20.0% | 10.0% | 15.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

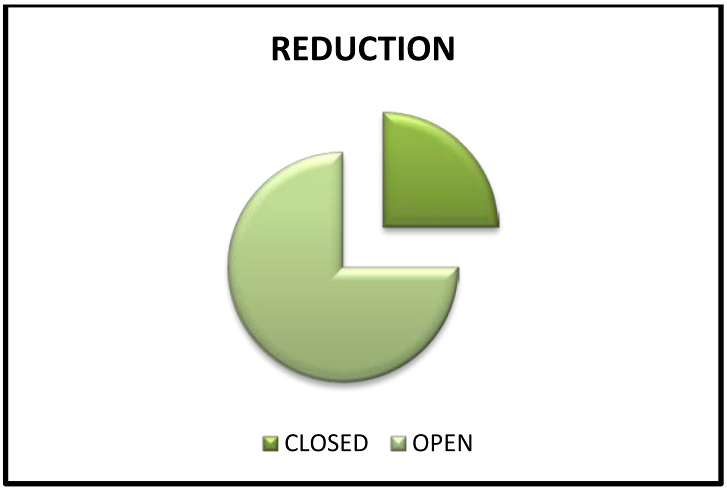
In our study we observed that 11 out of 20 cases were Lt sided and 9 out of the 20 cases were Rt sided




| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| SIDE | LT | Count | 6 | 5 | 11 |
| | | % within Groups | 60.0% | 50.0% | 55.0% |
| | RT | Count | 4 | 5 | 9 |
| | | % within Groups | 40.0% | 50.0% | 45.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

In our study among the 20 cases,15 cases were treated by closed reduction and 5 cases were treated by open reduction.Among the PFN case 50% of cases were reduced by closed reduction

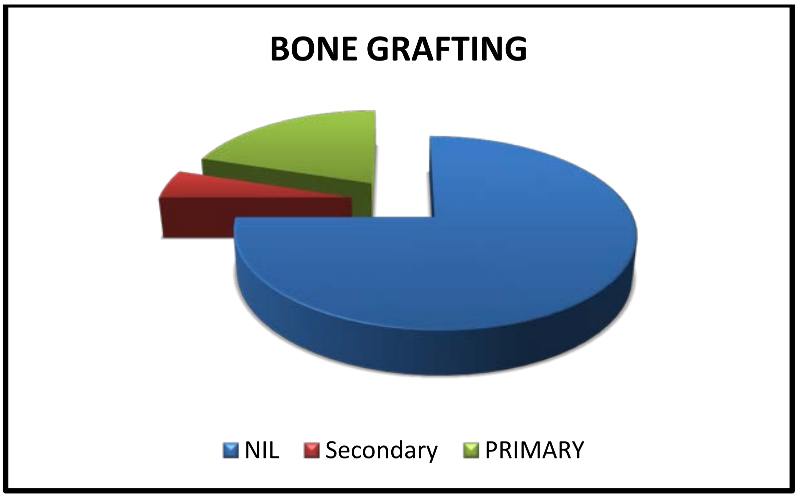


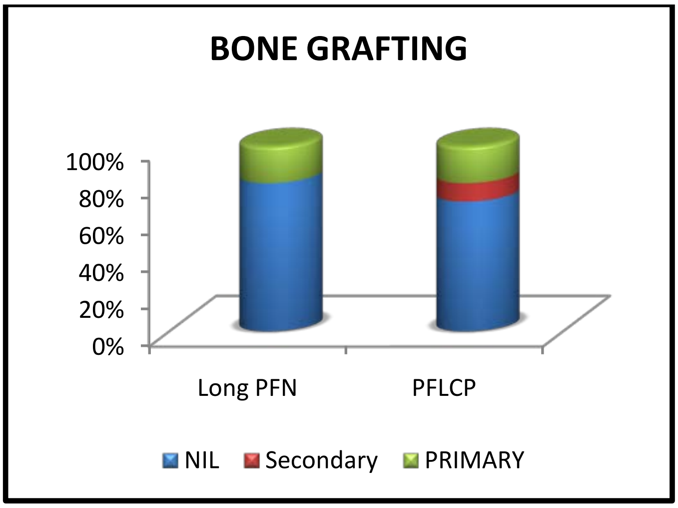




| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| REDUCTION | CLOSED | Count | 5 | 0 | 5 |
| | | % within Groups | 50.0% | 0.0% | 25.0% |
| | OPEN | Count | 5 | 10 | 15 |
| | | % within Groups | 50.0% | 100.0% | 75.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

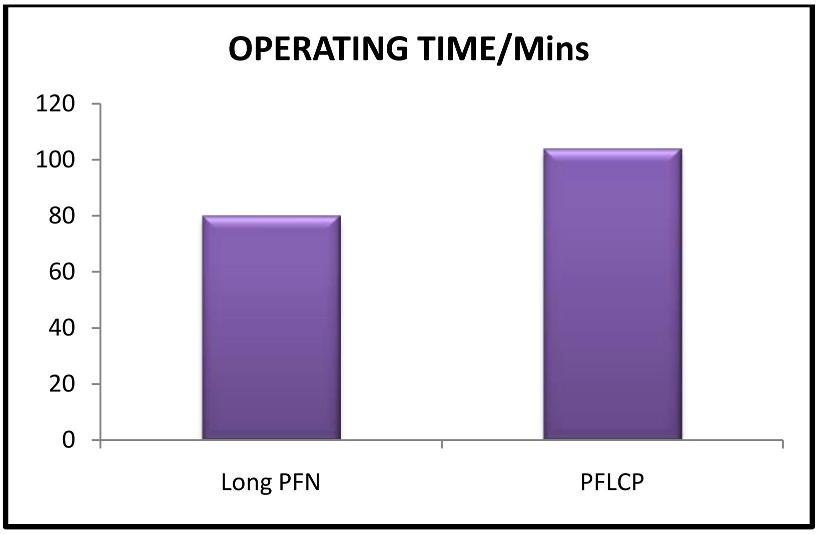
P value: 0.033,We observed that when the method of reduction was compared in PFN and PFLCP groups,50% of cases managed by PFN,reduction could be achieved by closed method and this is a significant difference in the method of reduction as compared to PFN and PFLCP group.

In our study bone grafting was done in  a total of 4 cases out of which 3 cases primary bone grafting was done and for one case secondary bone grafting was done.Out of the 3 cases of primary bone grafting ,2 were done for PFN patients and one for a acse treated by PFLCP.Secondary bone grafting was done for a case of PFLCP which had implant failure and later revision surgery was done with PFN  and secondary bone grafting.

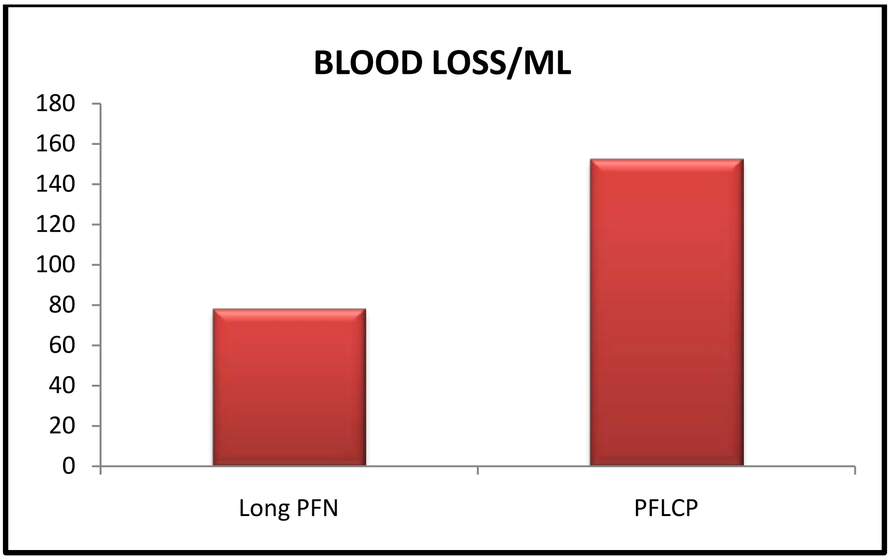




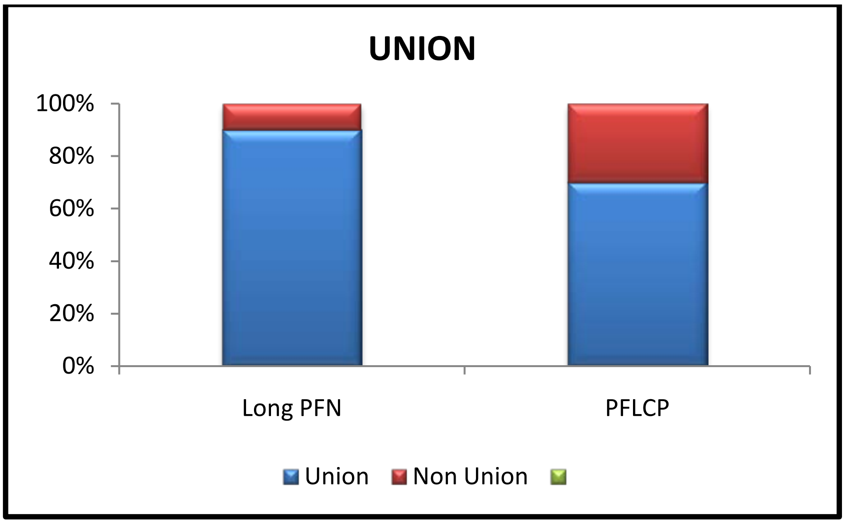

The average operating time in PFN patients was found to be 80 min and average operating time in PFLCP patients was found to be 104 minutes.

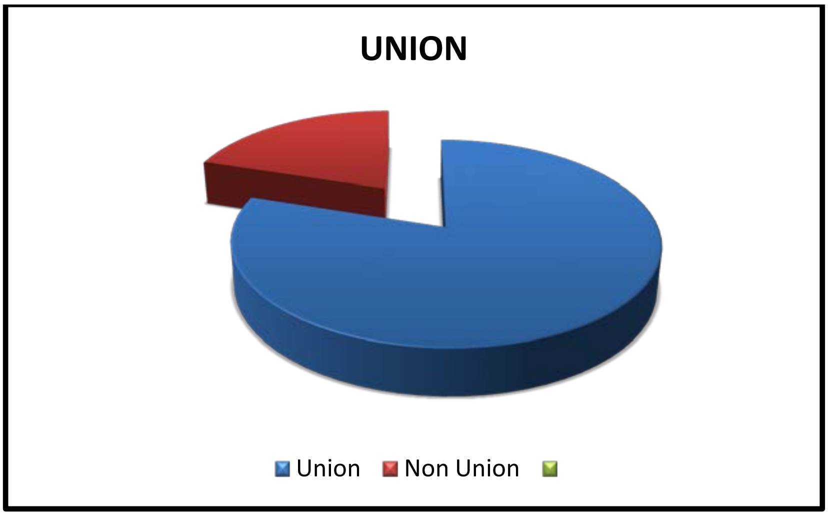



The average blood loss in PFN patients was found to be 78 ml and in PFLCP patients was found to be 152.50 ml




Out of the 20 cases 4 cases went for non union,Among the 4 cases ,3 were treated with PFLCP.Among the three cases for one of the case revision surgery was done with PFN.,One case which was managed by PFN went for hypertrophic non-union.

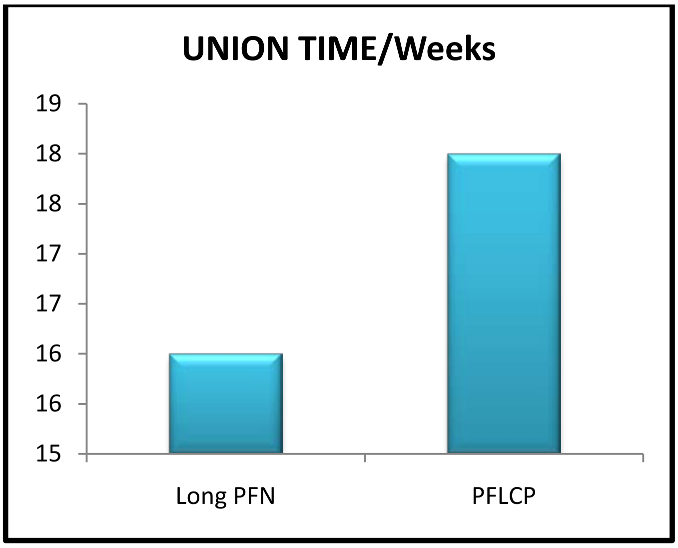




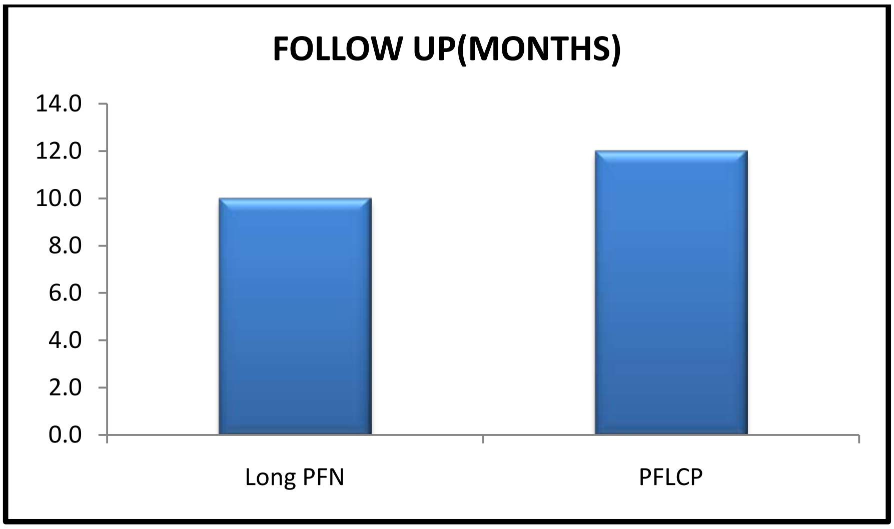

| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| UNION | Non Union | Count | 1 | 3 | 4 |
| | | % within Groups | 10.0% | 20.0% | 15.0% |
| | Union | Count | 9 | 7 | 16 |
| | | % within Groups | 90.0% | 70.0% | 80.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within | 100.0% | 100.0% | 100.0% |

P value on comparing the union rate of both grops was found to be 0.453 and it means there is not much stastical difference in union rates between 2 implants.

The average time for union in weeks for cases managed with PFN was found to be 16 weeks and those managed with PFLCP was found to be 18 weeks.




The average follow up of patients with PFN was 10 months for PFN and 12 months for PFLCP




In our study of 20 patients ,25% that is 5 patients had an excellent Harris Hip Score.Out of this 5 cases with excellent Harris hip score,4 cases were managed by PFN and 1 case managed by PFLCP.2 cases that is 20% of cases had a poor outcome and these 2 cases with poor outcome was managed by PFLCP.

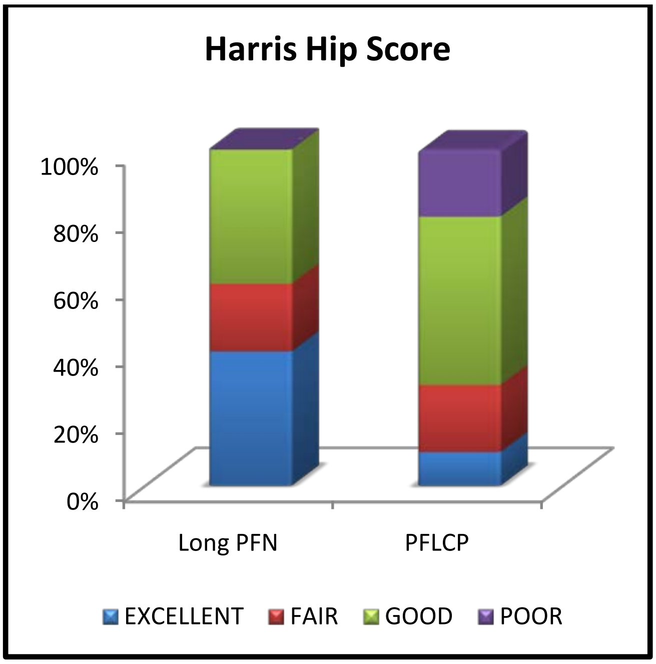
Patients with Harris Hip Score was categorised as follows:

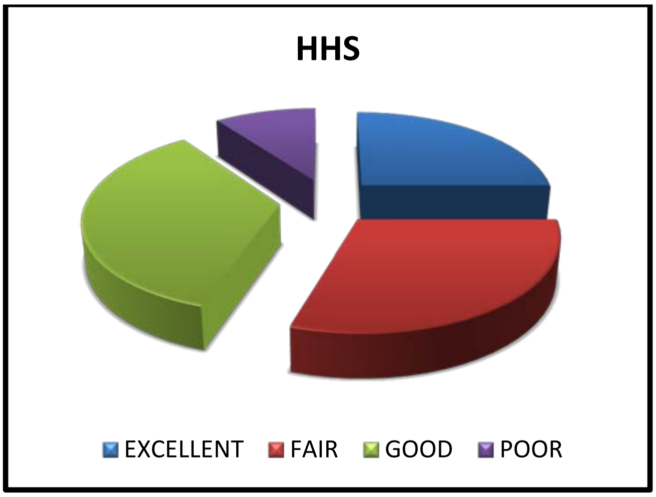
Excellent :90 – 100

Good : 80 – 90

Fair : 70-80

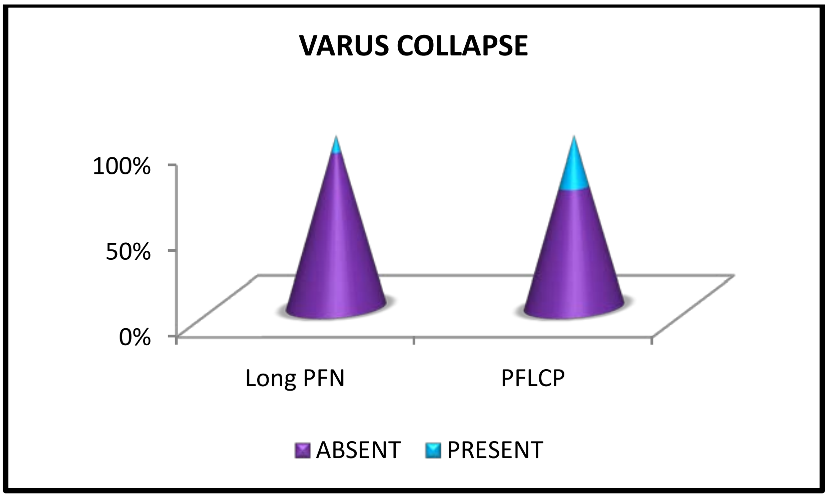
Poor :less than 70



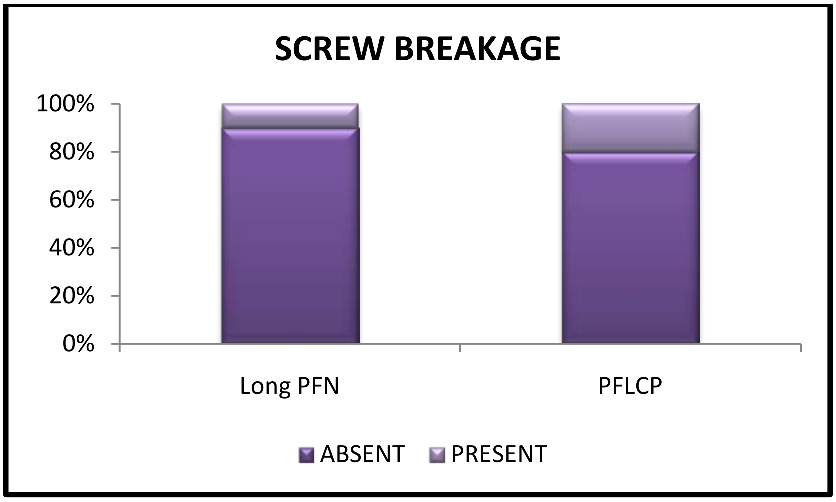



| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| HHS | EXCELLENT | Count | 4 | 1 | 5 |
| | | % within Groups | 40.0% | 10.0% | 25.0% |
| | FAIR | Count | 3 | 3 | 6 |
| | | % within Groups | 30.0% | 30.0% | 30.0% |
| | GOOD | Count | 3 | 4 | 7 |
| | | % within Groups | 30.0% | 40.0% | 35.0% |
| | POOR | Count | 0 | 2 | 2 |
| | | % within Groups | 0.0% | 20.0% | 10.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

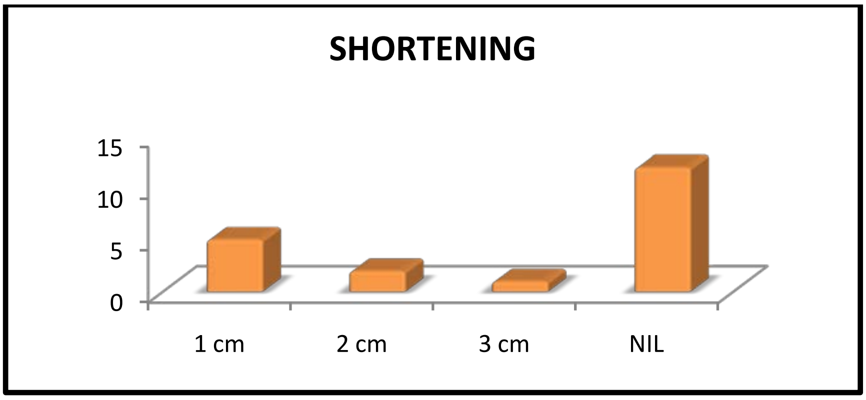
In our study of 20 patients varus collapse was seen and in 3 cases manged by PFLCP.

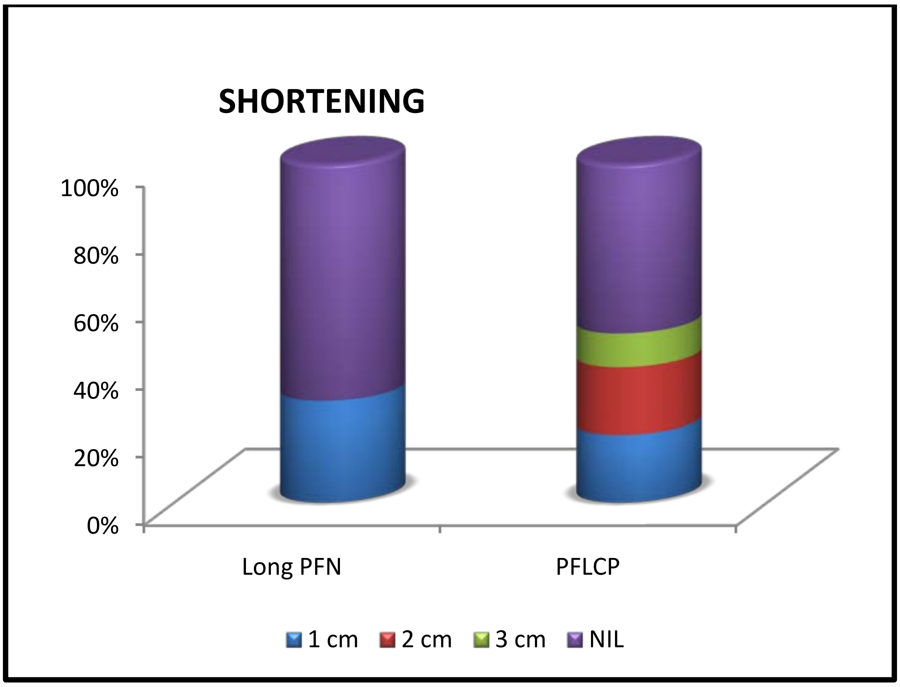


In our study screw breakage of proximal locking screws were seen in 2 cases managed by PFLCP and in one case of PFN there was breakage of derotation screw.




Among the 20 cases in our study, shortening was observed in 8 cases,out of which 3 cases was seen in PFN group and 5 cases belong to PFLCP group.3cm shortening was seen in one case ,all other cases had shortening of less than 3cm.

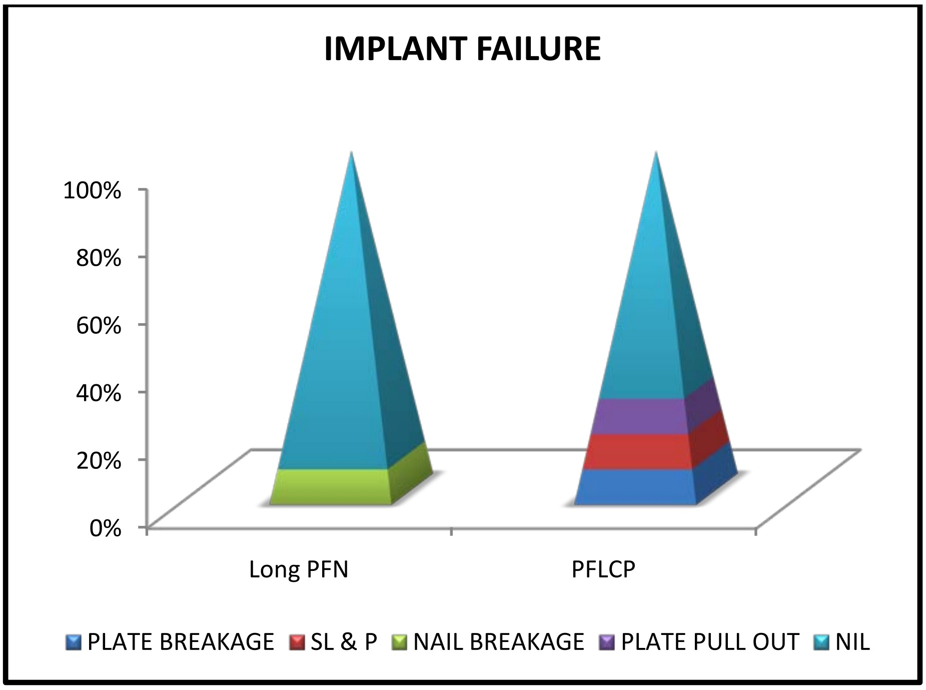


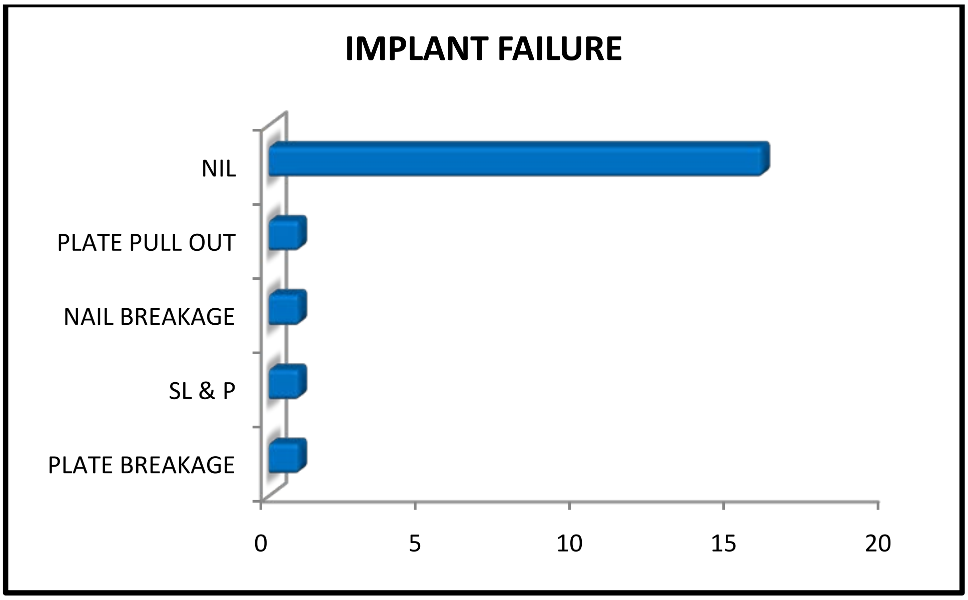



| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | |
| SHORTENING | 1CM | Count | 3 | 2 | 5 |
| | | % within Groups | 30.0% | 20.0% | 25.0% |
| | 2CM | Count | 0 | 2 | 2 |
| | | % within Groups | 0.0% | 20.0% | 10.0% |
| | 3CM | Count | 0 | 1 | 1 |
| | | % within Groups | 0.0% | 10.0% | 5.0% |
| | NIL | Count | 7 | 5 | 12 |
| | | % within Groups | 70.0% | 50.0% | 60.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

P value: 0.316

In our study no significant assosciation(p 0.316) was observed with shortening in both the group of patients.


IMPLANT FAILURE
100%
80%
60%
40%
20%
0%
Long PFN
PFLCP
PLATE BREAKAGE
SL & P
NAIL BREAKAGE
PLATE PULL OUT
NIL


IMPLANT FAILURE
NIL
PLATE PULL OUT
NAIL BREAKAGE
SL & P
PLATE BREAKAGE
0
5
10
15
20

| | | | Groups | | |
|---|---|---|---|---|---|
| | | | Long PFN | PFLCP | Total |
| IMPLANT FAILURE | ,SCREW LOOSENING , PLAT | Count | 0 | 1 | 1 |
| | | % within Groups | 0.0% | 10.0% | 5.0% |
| | NAIL BREAKAGE | Count | 1 | 0 | 1 |
| | | % within Groups | 10.0% | 0.0% | 5.0% |
| | NIL | Count | 9 | 7 | 16 |
| | | % within Groups | 90.0% | 70.0% | 80.0% |
| | PLATE BREAKAGE | Count | 0 | 1 | 1 |
| | | % within Groups | 0.0% | 10.0% | 5.0% |
| | PLATE PULL OUT | Count | 0 | 1 | 1 |
| | | % within Groups | 0.0% | 10.0% | 5.0% |
| Total | | Count | 10 | 10 | 20 |
| | | % within Groups | 100.0% | 100.0% | 100.0% |

| GROUPS | | MEAN | STD DEVIATION | P VALUE |
|---|---|---|---|---|
| AGE | PFN | 47.20 | 16.390 | 0.154 |
| | PFLCP | 57.50 | 14.524 | |
| UNION | PFN | 15.56 | 2.404 | 0.069 |
| | PFLCP | 18.00 | 3.024 | |
| OPERATING TIME | PFN | 80.00 | 13.944 | .001 |
| | PFLCP | 104.00 | 13.499 | |
| BLOOD LOSS | PFN | 78.00 | 13.375 | .000 |
| | PFLCP | 152.50 | 32.167 | |
| FOLLOW UP(MONTHS) | PFN | 9.80 | 2.440 | .301 |
| | PFLCP | 11.80 | 5.412 | |

Interpreatation of P value: P value >0.05 no significance,< 0.05 is significant and <0.01 highly significant

In our study on comparing the operating time and blood loss in PFN and PFLCP groups we observed that the differences were highly significant and the method of reduction when compared to PFN and PLCP group is also of significance.This indicates that there is a highly significant decrease in the average blood loss and operating time in cases treated by PFN when compared to PFLCP group and also closed reduction is seen more with cases managed by PFN when compared to PFLCP.

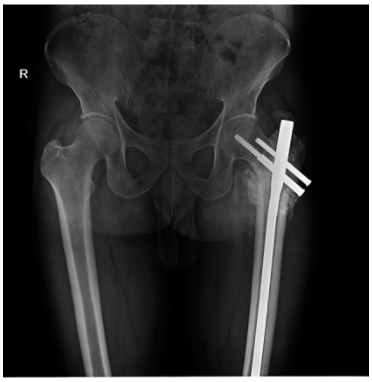
## PROXIMAL FEMUR NAIL CASES

| | |
|---|---|
| NAME | ISMAIL |
| AGE | 63 |
| SEX | MALE |
| MODE OF INJURY | ACCIDENTAL FALL |
| SIDE | LEFT |
| TYPE | RT IB |
| ASSOSCIATED INJURIES | NIL |
| RADIOLOGICAL UNION | 16 WEEKS |
| HARRIS HIP SCORE | 91;EXCELLENT |
| COMPLICATIONS | NIL |

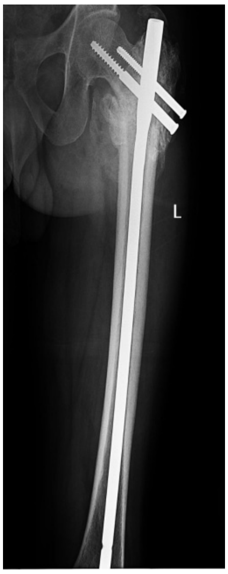
PRE OP

POST OP

16 WEEKS



6 MONTHS

**1 YEAR**

| | |
|---|---|
| NAME | SATISH |
| AGE | 37 |
| SEX | MALE |
| MODE OF INJURY | ACCIDENTAL FALL |
| SIDE | LEFT |
| TYPE | RT IB |
| ASSOSCIATED INJURIES | NIL |
| RADIOLOGICAL UNION | 12 WEEKS |
| HARRIS HIP SCORE | 93;EXCELLENT |
| COMPLICATIONS | NIL |


PRE OP


POST OP

8 WEEKS

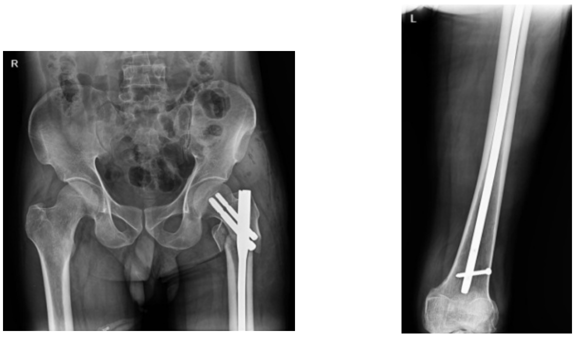

12 WEEKS AP VIEW

LATERAL VIEW



| | |
|---|---|
| **NAME** | **AMMASI** |
| **AGE** | **75** |
| **SEX** | **MALE** |
| **MODE OF INJURY** | **ACCIDENTAL FALL** |
| **SIDE** | **LEFT** |
| **TYPE** | **RT IB** |
| **ASSOSCIATED INJURIES** | **NIL** |
| **RADIOLOGICAL UNION** | **20 WEEKS** |
| **HARRIS HIP SCORE** | **71;FAIR** |
| **COMPLICATIONS** | **NAIL BREAKAGE,SHORTENING** |

**PRE OP**



**POST OP**

**5 MONTHS**

**8 MONTHS**

## COMPLICATIONS OF PFN

**NAIL AND LOCKING BOLT BREAKAGE**

**HYPERTROPHIC NON UNION**

**DEROTATION SCREW BREAKAGE**

**MYOSITIS OSSIFICANS**

## PROXIMAL FEMUR LOCKING PLATE CASES

| | |
|---|---|
| NAME | SARAVANAN |
| AGE | 33 |
| SEX | MALE |
| MODE OF INJURY | RTA |
| SIDE | LEFT |
| TYPE | RT IB |
| ASSOSCIATED INJURIES | NIL |
| RADIOLOGICAL UNION | 16 WEEKS |
| HARRIS HIP SCORE | 83;GOOD |
| COMPLICATIONS | NIL |

**PRE OP** **POST OP**

**8 WEEKS** **12 WEEKS** **16 WEEKS**

**6 MONTHS** **1 YEAR**

| | |
|---|---|
| **NAME** | **SUNDAR RAJ** |
| **AGE** | **47** |
| **SEX** | **MALE** |
| **MODE OF INJURY** | **RTA** |
| **SIDE** | **RIGHT** |
| **TYPE** | **RT IB** |
| **ASSOSCIATED INJURIES** | **NIL** |
| **RADIOLOGICAL UNION** | **16 WEEKS** |
| **HARRIS HIP SCORE** | **83;GOOD** |
| **COMPLICATIONS** | **NIL** |


**PRE OP**


**POST OP**


**8 WEEKS**

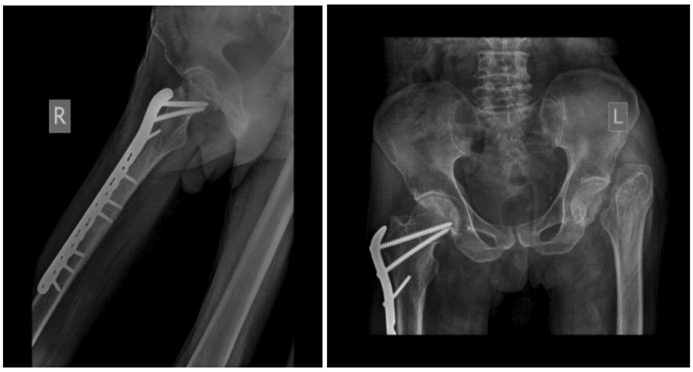

**16 WEEKS**

| | |
|---|---|
| **NAME** | **SUBRAMANI** |
| **AGE** | **75** |
| **SEX** | **MALE** |
| **MODE OF INJURY** | **ACCIDENTAL FALL** |
| **SIDE** | **RIGHT** |
| **TYPE** | **RT IA** |
| **ASSOSCIATED INJURIES** | **CHEST WALL INJURY** |
| **RADIOLOGICAL UNION** | **16 WEEKS** |
| **HARRIS HIP SCORE** | **75;GOOD** |
| **COMPLICATIONS** | **NIL** |

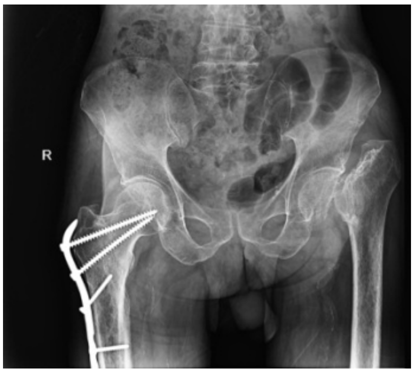

**PRE OP**


**POST OP**


**8WEEKS**




**16 WEEKS**



**6 MONTHS** **1 YEAR**

| | |
|---|---|
| NAME | KRISHNAN |
| AGE | 65 |
| SEX | MALE |
| MODE OF INJURY | ACCIDENTAL FALL |
| SIDE | RIGHT |
| TYPE | RT IB |
| ASSOSCIATED INJURIES | NIL |
| RADIOLOGICAL UNION | NON UNION |
| HARRIS HIP SCORE | 67;POOR |
| COMPLICATIONS | NONUNION,VARUSCOLLAPSE,<br>SHORTENING,<br>IMPLANT FAILURE |


PRE OP


POST OP


3MONTHS


6 MONTHS


**1 YEAR POST OP**

| | |
|---|---|
| **NAME** | **PALANISAMY** |
| **AGE** | **68** |
| **SEX** | **MALE** |
| **MODE OF INJURY** | **ACCIDENTAL FALL** |
| **SIDE** | **LEFT** |
| **TYPE** | **RT IB** |
| **ASSOSCIATED MORBIDITIES** | **HYPERTENSION** |
| **RADIOLOGICAL UNION** | **NON UNION** |
| **HARRIS HIP SCORE** | **71;FAIR** |
| **COMPLICATIONS** | **NONUNION,VARUSCOLLAPSE, SHORTENING,<br>IMPLANT FAILURE** |

**PRE OP**


**POST OP**


**BROKEN IMPLANT**


**IMPLANT EXIT**


**REVISION PFN SURGERY** **3 MONTHS**


**6 MONTHS**

## COMPLICATIONS OF PFLCP

SCREW BREAKAGE WITH VARUS COLLAPSE

VARUS COLLAPSE WITH SCREW AND PLATE PULL OUT

PLATE BREAKAGE WITH VARUS COLLAPSE

# DISCUSSION

In subtrochanteric fractures deforming forces are difficult to curtail and these fractures take a longer time to unite.Hence it is a great challenge for treating orthopaedicians. It still remains a controversial topic as to which is the best implant. The main system of implants widely used now are the intramedullary hip screw system, intramedullary interlocking nails and the plate screw systems each with its own advantages and disadvantages.

Intramedullary fixation has advantages over extramedullary implants as it is more of a biological fixation with less devasculariasation,less bleeding less surgical duration and early functional recovery.[50,53]Herscovici et al,in a retrospective study compared the functional outcomes of intramedullary and extramedullary implants and observed that functional results and complications rates were almost similar,but the advantages of intramedullary implants over extramedullary devices were in terms of less bleeding and faster surgical duration.

In our study of 20 patients the mean age was 52.3 years ,which was similar to a study conducted by[54] Lei-Sheng Jiang et al where the average age of patients was 53years,a study similar to our study where comparative analysis of subtrochanteric fractures between locking plate and cephalomedullary nailing , by [54ii]Philip N. Streubel et al,average age incidence was 63 years.In our study there was a male predominance and 90% of the patients were males with only 10% females.In a study conducted by [55]Wei Ting Lee et al,also a male pre ponderance was seen with 21 men out of 26 total cases.Indian studies like those conducted by [56]Shah et al and[57] Prabhat Agarwal et al shows again a male preponderance,but many of the western studies like those by[58] Michael Moustoukas et al showed an almost equal incidence in both sexes.The higher incidence in males may be due to increased activity among males.

We observed in our study that the mechanism of injury in majority our patients was following road traffic accidents with 60 % of cases sustained fractures following RTA and 40% of cases following accidental fall,a study conducted by [32]Subramanyam Yadlapalli et al also showed similar results.

In our study majoriy of the cases were classified under Russel Taylor Type IB subtrochanteric fractures,a study by [59]French et al observed 45 cases of Russel Taylor Type IB subtrochanteric fractures.

In our study 25% of cases was reduced by closed reduction.A study by[59]Wiss Donald et al showed 69 cases treated by closed reduction.In a study by [60]Wen Yue Wang et al 80 % of cases were reduced by closed reduction.In a study by [61]N Tzachev et al out of 100 cases 60 cases were reduced by closed reduction and 40 cases by open reduction.All cases treated by PFLCP we had to do an open reduction in order to achieve good anatomical fracture reduction,whereas 50% of cases managed by PFN we could achieve open reduction without disturbing the fracture haematoma.The average blood loss in PFLCP group was 152.50. ml.The results of other similar studies are as follows:

| STUDIES | BLOOD LOSS |
|---|---|
| [62]NAIYER ASIF et al | 250 -300 ML |
| [44]ARCHIT K et al | 200 ML |
| [63]ASHUTOSH K. SINGH etAL | 200-300ML |
| OUR STUDY | 152.50 ML |

The average blood loss in PFN was 78.00ml,there is a significant difference in the amount of blood loss in PFN groups when compared to the PFLCP group(p value 0.00)Studies by[64] V.Srivastava et al where PFN was compared to PFLCP also had a p value less than 0.001.Other studies which showed blood loss in PFN comparative to our studies are:

| STUDIES | BLOOD LOSS |
|---|---|
| [65]S.MITTAL et al | 98.5ML |
| [66]SUBHADIP et al | 124.0ML |
| [67]MINOS TYLLIANAKIS | 150.0ML |
| [68]ISHRAT et al | 110.0ML |
| OUR STUDY | 78.00ML |

The average operating time also was significantly lower for PFN group when compared to the PFLCP group. Majority of the cases of PFN, reduction was aslo achieved easily when compared to the PFLCP group.A study conduted by [69]Sadowski et al observed mean duration of surgery 82 min for PFN ,in our study mean duration of surgery was 80 min for PFN.The mean duration of surgery for PFLCP in our study was 104 min. A study by [40]Diarmuid Murphy et al showed an operating time of 163.2 min for PFLCP.In studies all around the world ,the duration of surgery highly varies .The duration of surgery is largely dependent on the skill and experience of the operating surgeon as well as the nature of fracture pattern.

We had a very good union rate in our cases with 90% union rate for cases treated with PFN,with only a single case that went for hypertrophic non union.Other studies also showed almost similar union rates

| STUDIES | UNION RATES |
|---|---|
| [49]H.BANNAN et al | 85% |
| [54]JIANG et al | 97% |
| [60]WANG Wen Yue et al | 96% |
| [44]GUNNINDER GOSAL et al | 93.4% |
| OUR STUDY | 90% |

Union rates in PFLCP was 70% ,with 3 cases of non union and .Out of the 3 cases , for one case revision surgery was done with PFN and secondary bone grafting.Our study results were comparable with other study results.

| STUDIES | UNION RATES |
|---|---|
| [41]Mark.W.Floyd et al | 78% |
| [70]Saini et al | 90.6% |
| [62]Owais Ahmed et al | 80% |
| [57]Raghavendra et aln | 78% |
| [46]Nishanth Kumar et al | 80% |
| OUR STUDY | 70% |

In our study we observed that cases treated with PFN union was achieved in a mean of 16 weeks .Other studies where union time for PFN was analysed and similar to our study were:

| STUDY | UNION TIME |
|---|---|
| [71]S.V.YADIKAR et al | 16 weeks |
| [72]GURINDER GOSAL et al | 14 weeks |
| [4]THAPA et al | 3-3.5 months |
| [73]KORHAN OZKAN et al | 16.5 weeks |
| [74]PRASAD M GOWDA et al | 4.6 months |
| OUR STUDY | 16 weeks |

Full weight bearing was started based on radiological evidence of callus formation. Non weight bearing was started from the 3$^{rd}$ post operative day depending on the pain tolerance level by the patient.Partial weight bearing was started between 3- 6 weeks.Most of the patients started full weight bearing by 3- 4 months.

In cases treated with PFLCP union was achieved in a mean of 18 weeks.Our analysis was comparable with other studies

| STUDIES | UNION TIME |
|---|---|
| [75]Jae Hoon Jang et al | 5.4 months |
| [40]Wei Ting Lee et al | 11.0 weeks |
| [76]Hossain M et al | 16 weeks |
| OUR STUDY | 18 weeks |

Weight bearing was delayed in cases treated with PFLCP and full weight bearing was started only after complete radiological evidence of callus formation.

In our study we observed that 80% of cases in PFN group had good to excellent Harris Hip Score ,[71]S.V. Yadikar et al in their study had 92% of cases with good to excellent results.In PFLCP group 60 % of cases had good to excellent Harris Hip Score ,study by[56] P.K.Chalise it was observed that 88% of cases had a good to excellent Harris Hip Score whereas in a study by [46]Nishanth kumar et al a good to excellent Harris Hip Score was seen in 77.5% of patients.

Among the cases treated with PFN all cases union was achieved except for one case which showed hypertrophic non union at the end of 10 months.The cause for non union in this patient could be due to inability to achieve posteromedial cortical continuity,lack of an accurate reduction , excessive distraction at the fracture site and inherent nature of the fracture pattern to go for non union.Non union could be avoided in this patient if we had done a proper reduction of the fracture fragments and primary bone grafting.

Another PFN case that had implant failure ,had breakage of distal locking bolts,breakage of the nail distal to the lag screw.The nail broke at 6 months of folIow up but eventually the fracture united with varus collapse of the proximal fragment.Reason for braeakage of the nail could be due to the failure to achieve posteromedial continuity and inadequate reduction.

In a study by[77] B Kanthimathi et al,it was observed that the rate of implant breakage in PFN was 4%.They observed a complication rate of 20%.[77]The inherent instability of the fracture pattern and the difficulty to achieve medial buttressing is considered as a cause of failure in PFN fixation. Studies on subtrochanteric fractures using PFN by [63]Lei-Sheng Jiang et al showed one case of delayed union on their study.[78]Philip N.Streubel et al in their study had 5% non-union. [79]In a study by

Gadegone and Salphale 100 cases treated by PFN,complications like femoral head cut through was seen in 4.8% of patients,implant breakage in 0.8% and intra-operative femoral shaft fractures 0.8%.

In one of our cases with PFN,cerclage wiring was done,this patient achieved union by 12 weeks.Tomas et al emphasised the importance of cerclage wiring ,and all cases in his study showed complete union.[80]

Codesido et al in a study compared open reduction and cerclage wiring with closed reduction and found that patients treated with cerclage wiring had better results than open reduction.For this same case bone grafting was also done. A study by [4,50]Thapa.P. et al advocated bone graft as a routine procedure in all comminuted subtrochanteric fractures without posteromedial comtinuity. Bone grafting acts as protection factor for fixation device and prevents the varus deformity .

For better functional outcomes in PFN ,an ideal entry point and reduction is crucial.[80]Paulo Roberto Barbosa and Streubel et al in their study after analysing 50 x rays of normal hips demonstrated that the ideal entry point was medial to the tip of greater trochanter in 70% of patients and lateral in the remaining patients.Inspite of evolution of different implants for subtrochanteric fractures,reduction is considered as isolated crucial factor in prognosis of subtrochanteric fractures. [4,54]Lag screw should be applied to the inferior part of the femoral neck close to the calcar in anteroposterior view and right in the central in lateral view.The screw tip should reach the subchondral bone,5-10 mm below the articular cartilage.[81]Miedel et al in their study analysing the results of intramedullary fixation in the treatment of subtrochnateric fractures,observed that in those cases with acceptable reduction,the rate of reoperation was 23% whereas those with good rduction,no patients were reoperated.The aim should be to restore the cervico diaphseal angle ,in addition to the correction of rotation and flexion of the proximal fragment with methods that cause minimal biological damage.

One of our patients with good union had heterotropic ossification which was an incidental finding.Union was achieved in this case.[82]In a study by Domingo et al calcification noticed at the tip of greater trochanter in 13 out of 295 patients.

Among the patients operated with PFLCP,we had 3 cases of implant failure. Revision surgery using PFN was done for one of the cases,2 other cases no revision procedure was done. One of the patients had plate breakage after 6 months with varus collapse .Plate exit was done and revision surgery with long PFN was with cerclage wiring with bone grafting was done.Patient has not attained complete radiological union till now and has varus collapse.Patient also has a significant shortening of 3cm.Causes for implant failure in this patient was due to varus malreduction at the time of surgery,medial comminution and distraction at the fracture site which would have causes high stress at the plate screw interface,eventually leading to plate breakage.We could have avoided this complications by achieving a perfect reduction and earlier bone grafting.

Another case where PFLCP fixation was done, had implant failure at 6 months.We had intra operative complication of breakage of drill bit in this case.In this case we had achieved an acceptable reduction of the fracture fragments and poteromedial continuity was also well maintained.Only 2 proximal locking screws was applied to the head.No union was achieved even after 6 months.On weight bearing, patient developed varus collapse with breakage of screws and proximal loosening of screws with plate pull out. In this patient we could have reduced the fragments with interfragmentary screws,which would have further enhanced the stability,as well as secondary bone grafting after no evidence of union would have decreased the risk of implant failure.We should have applied all the three proximal locking screws into the head.These reasons along with the inherent nature of non union and devascularisation of the fragments could be the cause of failure.

Another patient had implant failure at 8 weeks follow up. Patient was not compliant and started weight bearing early inspite of strict advise.In this case the caise of failure was due to early weight bearing of the patient even before evidence of callus formation and lack of posteromedial continuity.

.In a study by [41]Mark.W.Floyd et al,23% of patients had catastrophic failure of the implant and revision rate was 46%. [43]Glassner and Tejwani reported a 70% failure rate in their studies,30% of cases developed varus collapse,20% of cases had breakage of plates.In a study by[62] Naiyer Asif et al union rate was found to be 92%, 3(12%) patients developed bending or breakage of proximal screws and 3 (12%) cases varus collapse was observed.They observed that the failure was due to early weigh bearing before callus formation, and they observed that in all the failure cases there was a lack of posteromedial continuity and patients were unreliable and non compliant with weight bearing. [83]Wirtz et al recently in their study reported 37 % complications in their study included important complications such as infection,cut out and varus collapse which required revision surgeries.In a study by [83]Karl Wieser et al it was observed seen that 4 among total of 14 cases showed failure.

We observed that the cause of failure in our study among PFLCP patients was due to mechanical stress at the plate screw interface caused due to early weight bearing on the affected leg ,before bone healing has been completed.This was observed by[84] Haidukewych etal in their study the cause of plate breakage was  due to the inability to win the race between fracture healing and implant failure among the patients.

[41] Factors important in plate fixation are : critical technique and good surgical experience, protected weight bearing until evidence of bony healing is important, good anatomical reduction of the fracture fragments and maintenance of posteromedial continuity. On weight bearing, mechanical stress acts on the femur  and the highest compression stress is seen at an area 3cm distal to lesser trochanter,so the main focus is on medial cortical buttress, bending forces causes medial cortex to be loaded in compression and the lateral cortex in tension. As comminution increases the biomechanical stability decreases. In cases of inadequate medial cortical support the internal fixation device wil act as a tension band in lateral femoral cortex, and loads are concentrated in an area of the implant resulting in implant failure and loss of fixation.

One of the key factures in subtrochanteric fractures is good anatomical reduction, In our study we observed that in a patient where we had done a good anatomical reduction using interfragmentary screws, the bone healing and union was quicker when compared to other cases where we had not used this techniques. We also observed that this patient had an excellent HARRIS hip score and weight bearing was stated earlier, Another case where we had done primary bone grafting healed well with excellent HARRIS hip score, in this case bone grafting was done in order to maintain the posteromedial continuity.

The concept of lateral trochanteric wall as a stabilising factor in management of subtrochanteric fractures led to the development of concept of locking plates for subtrochanteric fracture management. Following observations which we made in our study while using PFLCP were:

1. Delayed weight bearing, toe touch weight bearing can be delayed in unstable fractures with limited posteromedial continuity. Earlier weight bearing can be started in fracture with good posteromedial cortical contact.
2. Plate once locked in its position does not permit further collapse or does not increase the cortical contact, hence open reduction must be done whenever doubtful about reduction which further adds to blood loss and causes devascularisation of the fragments.
3. Avoid distraction while fixing which increases risk of implant breakage as the fracture heals.
4. Plate positioning and screw placement is crucial ,the proximal tip of the plate should engage with the tip of the greater trochanter and the plate with increased length spanning the whole fracture are more

reliable.Proximal screws should be as long as possible and inferior most head screw should engage the calcar.

5. We observed that bone grafting must be considered in cases of subtrochanteric fractures both as a primary or secondary procedure .

In a study by [7]Jie Wang et al where biomechanical evaluation of different implants like PFN and PFLCP was compared it was observed that PFN was superior biomechanically than other implants in terms of its construct. We observed that PFN has more advantages as compare to PFLCP, PFN has shorter bending lever arm and it can bear more compressive stresses on medial cortex of proximal femur.PFN also prevents varus collapse of the medial cortex of subtrochanteric region thus reducing the incidence of failure rate. In our study we observed that even though there were no major differences in the functional outcomes and union, implant failure was more assosciated with PFN and there is significant decrease in the amount of blood loss and operating time in patients treated with PFN when compared to patients managed by PFLCP. Our observation was similar to study by[64] V.Srivastava et al where they observed that the blood loss, operating time and incision length was significantly lower in PFN when compared to PFLCP.

# CONCLUSION

Both PFN and PFLCP are effective in the management of subtrochanteric fractures.Subtrochanteric fractures are fractures which take a longer time for union .No major differences were noted in the functional outcomes and complication between the PFN and PFLCP .Advantages of PFN over PFLCP are decreased blood loss,decreased duration of surgery and less devascularisation of the fracture fragments,with less disturbance of fracture haematoma, due to increased chances of closed reduction in PFN over PFLCP.

# BIBLIOGRAPHY


1. Nath RG, Ansari S. Role of Proximal Femoral Locking Plate in treatment of Subtrochanteric Fractures ; Case series. 2017;3(July):1–7.

2. A retrospective analysis of surgically-treated complex proximal femur fractures with proximal femoral locking compression plate. Rev Bras Ortop (English Ed [Internet]. 2017 Jan 7 [cited 2017 Oct 11]; Available from: http://www.sciencedirect.com/science/article/pii/S2255497116301471

3. Hu S-J, Zhang S-M, Yu G-R. Treatment of femoral subtrochanteric fractures with proximal lateral femur locking plates. [Internet]. Vol. 20, Acta ortopedica brasileira. 2012. p. 329–33. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3861956&tool=pmcentrez&rendertype=abstract

4. Chakraborty M, Thapa P. Fixation of subtrochanteric fracture of the femur: Our experience. J Clin Diagnostic Res. 2012;6(1):76–80.

5. Hak DJ, Wu H, Dou C, Mauffrey C, Stahel PF. Challenges in Subtrochanteric Femur Fracture Management. Vol. 38, Orthopedics. 2015. p. 498–502.

6. Resident S, Consultant J, Hospital Z, Resident S. Outcome

evaluation of dynamic condylar screw fixation for subtrochanteric femur fracture. 2017;3(1):351–5.

7. Wang J, Ma J, Jia H, Chen Y, Yang Y, Ma X. Biomechanical Evaluation of Four Methods for Internal Fixation of Comminuted Subtrochanteric Fractures [Internet]. Vol. 95, Medicine. 2016. p. e3382. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005792-201605100-00015

8. Li F, Sang W, Wang Q, Huang J, Lu H. Subtrochanteric fracture treatment: A retrospective study of 46 patients. Med Princ Pract. 2011;20(6):519–24.

9. Stevens J. Orthopaedic Biomechanics. By VH Frankel, AH Burstein, 188 pp, 24 cm, illus, Lea & Febiger, Philadelphia, 1970. Arthritis Rheum [Internet]. 1971 Jan 1 [cited 2017 Oct 13];14(1):144–144. Available from: http://doi.wiley.com/10.1002/art.1780140124

10. Tencer a F, Johnson KD, Johnston DW, Gill K. A biomechanical comparison of various methods of stabilization of subtrochanteric fractures of the femur [Internet]. Vol. 2, Journal of Orthopaedic Research. 1984. p. 297–305. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubm

ed&dopt=Abstract&list_uids=6491820&query_hl=57&itool=pubmed_docsum

11. [Paul_T.

12. Pajarinen J, Lindahl J, Michelsson O, Savolainen V, Hirvensalo E. Pertrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail A RANDOMISED STUDY COMPARING POST-OPERATIVE REHABILITATION. J Bone Jt Surg [Br] [Internet]. 2005 [cited 2017 Oct 12];87:76–81. Available from: http://www.boneandjoint.org.uk/content/jbjsbr/87-B/1/76.full.pdf

13. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. In: Parker MJ, editor. Cochrane Database of Systematic Reviews [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2010 [cited 2017 Oct 12]. p. CD000093. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20824825

14. Gardner MJ, Johnson EE, Lorich DG, Contraindications I. Subtrochanteric Femur Fractures : Plate Fixation. 2006. p. 1–25.

15. Craig NJ, Sivaji C, Maffulli N. Subtrochanteric fractures. A review of treatment options. Bull Hosp Jt Dis [Internet]. 2001;60(1):35–46. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11759576

16. Bajaj HN, Sripathi Rao P, Kumar B, Chacko V. Subtrochanteric fractures of the femur-an analysis of the results of operative and non-operative management. Injury [Internet]. 1988 [cited 2017 Oct 12];19:169–71. Available from: http://www.injuryjournal.com/article/0020-1383(88)90008-3/pdf

17. Subtrochanteric fractures. A review of treatment options [Internet]. [cited 2017 Oct 13]. Available from: https://www.researchgate.net/publication/11597376_Subtrochanteric_fractures_A_review_of_treatment_options

18. Parker MJ, Dutta BK, Sivaji C, Pryor GA. Subtrochanteric fractures of the femur. Injury [Internet]. 1997 Mar 1 [cited 2017 Oct 13];28(2):91–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9205572

19. WADDELL JP. Subtrochanteric Fractures of the Femur. J Trauma Inj Infect Crit Care [Internet]. 1979 Aug [cited 2017 Oct 13];19(8):582–92. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005373-197908000-00006

20. Closed treatment of subtrochanteric fractures of the femur i... : JBJS [Internet]. [cited 2017 Oct 13]. Available from:

http://journals.lww.com/jbjsjournal/Abstract/1981/63050/Closed_treatment_of_subtrochanteric_fractures_of.12.aspx

21. Femoral Shaft Fractures: Percutaneous Multiple Pin Fixation,... : Clinical Orthopaedics and Related Research [Internet]. [cited 2017 Oct 13]. Available from: http://journals.lww.com/corr/Citation/1971/06000/Femoral_Shaft_Fractures__Percutaneous_Multiple_Pin.17.aspx

22. Negative Experiences with Pins-in-plaster for Femoral Fractu... : Clinical Orthopaedics and Related Research [Internet]. [cited 2017 Oct 13]. Available from: http://journals.lww.com/corr/Citation/1979/01000/Negative_Experiences_with_Pins_in_plaster_for.34.aspx

23. Ali M. Treatment of comminuted subtrochanteric fractures by dynamic hip screw. J Pak Med Assoc. 1995;45(8):212–5.

24. Vashisht D, Sreen S, Daroch MS, Alawadhi K. Dynamic condylar screws versus 95$^{o}$ angle blade plate fixation of subtrochantric fractures of femur. 2017;5(5):2040–5.

25. Different Ways to Treat Subtrochanteric Fractures With the M... : Clinical Orthopaedics and Related Research [Internet]. [cited 2017 Oct 13]. Available from:

http://journals.lww.com/corr/Abstract/1998/03000/Different_Ways_to_Treat_Subtrochanteric_Fractures.17.aspx

26. Wani M. Subtrochanteric Fractures-Current Management Options. Internet J Orthop Surg [Internet]. 2009 [cited 2017 Oct 15];17(2). Available from: https://print.ispub.com/api/0/ispub-article/8827

27. Hu S-J, Zhang S-M, Yu G-R. Treatment of femoral subtrochanteric fractures with proximal lateral femur locking plates. Acta Ortop Bras [Internet]. 2012 Dec [cited 2017 Oct 13];20(6):329–33. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24453626

28. Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. Clin Orthop Relat Res [Internet]. 2004 Aug [cited 2017 Oct 13];(425):82–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15292791

29. Hasenboehler EA, Agudelo JF, Morgan SJ, Smith WR, Hak DJ, Stahel PF. Treatment of Complex Proximal Femoral Fractures With the Proximal Femur Locking Compression Plate. Orthopedics [Internet]. 2007 Aug 1 [cited 2017 Oct 15];30(8). Available from: https://www.healio.com/orthopedics/journals/ortho/2007-8-30-8/%7Bb986a9ed-478a-44cd-9414-8b3738604c95%7D/treatment-of-complex-proximal-femoral-fractures-with-the-proximal-femur-locking-

compression-plate

30. Contralateral reversed distal femoral locking plate for fixation of subtrochanteric femoral fractures. Chinese J Traumatol [Internet]. 2015 Oct 1 [cited 2017 Oct 15];18(5):279–83. Available from: http://www.sciencedirect.com/science/article/pii/S1008127515001029

31. Groves EWH. Ununited fractures, with special reference to gunshot injuries and the use of bone grafting. Br J Surg [Internet]. 1918 Jan 1 [cited 2017 Oct 13];6(22):203–47. Available from: http://doi.wiley.com/10.1002/bjs.1800062207

32. Of AS, Of M, Fracture S, By F, Nailing P, To DS. a Study of Management of Subtrochanteric Fracture Femur By Proximalfemoral Nailing Dissertation Submitted To. 2011;(December):1–85.

33. Subtrochanteric fractures of the femur. : JBJS [Internet]. [cited 2017 Oct 13]. Available from: http://journals.lww.com/jbjsjournal/Abstract/1978/60030/Subtrochanteric_fractures_of_the_femur_.4.aspx

34. INTRAMEDULLARY NAIL FIXATION AS TREATMENT OF SUBTROCHANTERIC... : Journal of Trauma and Acute Care Surgery [Internet]. [cited 2017 Oct 14]. Available from: http://journals.lww.com/jtrauma/Citation/1971/08000/INTRAMEDULLA

RY_NAIL_FIXATION_AS_TREATMENT_OF.1.aspx

35. Halder SC. THE GAMMA NAIL FOR PERITROCHANTERIC FRACTURES. J Bone Jt Surg [Br] [Internet]. 1992 [cited 2017 Oct 14];74:340–4. Available from: https://pdfs.semanticscholar.org/9444/0a5ed21969f7b0370354e5beaa8c82849de2.pdf

36. Simmermacher RK, Bosch AM, Van der Werken C. The AO/ASIF-proximal femoral nail (PFN): a new device for the treatment of unstable proximal femoral fractures. Injury [Internet]. 1999 Jun [cited 2017 Oct 13];30(5):327–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10505125

37. Hodel S, Beeres FJP, Babst R, Link B-C. Complications following proximal femoral locking compression plating in unstable proximal femur fractures: medium-term follow-up. Eur J Orthop Surg Traumatol [Internet]. 2017 May 25 [cited 2017 Oct 18];1–8. Available from: http://link.springer.com/10.1007/s00590-017-1981-1

38. Lin K-J, Wei H-W, Lin K-P, Tsai C-L, Lee P-Y. Proximal femoral morphology and the relevance to design of anatomically precontoured plates: a study of the Chinese population. ScientificWorldJournal [Internet]. 2014 Nov 3 [cited 2017 Oct 13];2014:106941. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/25530989

39. 4.5 mm LCP Proximal Femur Plates. Part of the Synthes Periarticular LCP Plating System. Technique Guide. [cited 2017 Oct 13]; Available from: http://synthes.vo.llnwd.net/o16/LLNWMB8/US Mobile/Synthes North America/Product Support Materials/Technique Guides/SUTG4.5LCPprxfemurJ4868E.pdf

40. Ting Lee W, Murphy D, Kagda FH, Thambiah J. Proximal femoral locking compression plate for proximal femoral fractures. J Orthop Surg [Internet]. 2014 [cited 2017 Oct 13];22(3):287–93. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.662.5435&rep=rep1&type=pdf

41. Floyd MW, France JC, Hubbard DF. Early Experience With the Proximal Femoral Locking Plate. Orthopedics [Internet]. 2013;36(12):e1488–94. Available from: http://www.healio.com/doiresolver?doi=10.3928/01477447-20131120-11

42. Gunadham U, Jampa J, Suntornsup S, Leewiriyaphun B. The outcome in early cases of treatment of subtrochanteric fractures with proximal femur locking compression plate. Malaysian Orthop J [Internet]. 2014 Jul [cited 2017 Oct 13];8(2):22–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25279088

43. Glassner PJ, Tejwani NC. Failure of Proximal Femoral Locking Compression Plate: A Case Series. J Orthop Trauma [Internet]. 2011 Feb [cited 2017 Oct 13];25(2):76–83. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21245709

44. Govindasamy R, Gnanasundaram R, Kasirajan S, Meleppuram JJ, Archit K. Proximal femur locking compression plate in complex proximal femoral fractures: a retrospective analysis. Int J Res Orthop [Internet]. 2016 Sep 3 [cited 2017 Oct 13];2(3):104. Available from: http://www.ijoro.org/index.php/ijoro/article/view/67

45. Crist BD, Khalafi A, Hazelwood SJ, Lee MA. A Biomechanical Comparison of Locked Plate Fixation With Percutaneous Insertion Capability Versus the Angled Blade Plate in a Subtrochanteric Fracture Gap Model. J Orthop Trauma [Internet]. 2009 Oct [cited 2017 Oct 13];23(9):622–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19897982

46. Kumar N, Kataria H, Yadav C, Gadagoli BS, Raj R. Evaluation of proximal femoral locking plate in unstable extracapsular proximal femoral fractures: Surgical technique & mid term follow up results. Vol. 5, Journal of Clinical Orthopaedics and Trauma. 2014. p. 137–45.

47. Resident S. Efficacy of proximal femoral locking compression

plate in the management of unstable extracapsular proximal femur fractures. 2016;2(November 2012):163–6.

48. Synthes. PFN – Proximal Femoral Nail. Image (Rochester, NY). 2006;

49. Banan H, Al-Sabti A, Jimulia T, Hart AJ. The treatment of unstable, extracapsular hip fractures with the AO/ASIF proximal femoral nail (PFN)--our first 60 cases. Injury [Internet]. 2002 Jun [cited 2017 Oct 13];33(5):401–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12095719

50. Surgery J. Subtrochanteric fractures of the femur of the Femur. 2009. p. 300–6.

51. Yoon RS, Donegan DJ, Liporace FA. Reducing Subtrochanteric Femur Fractures. J Orthop Trauma [Internet]. 2015 Apr [cited 2017 Oct 14];29:S28–33. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005131-201504001-00006

52. Afsari A, Liporace F, Lindvall E, Infante A, Sagi HC, Haidukewych GJ. Clamp-Assisted Reduction of High Subtrochanteric Fractures of the Femur. J Bone Jt Surgery-American Vol [Internet]. 2009 Aug [cited 2017 Oct 14];91(8):1913–8. Available from:

http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00004623-200908000-00011

53. Herscovici D, Pistel WL, Sanders RW. Evaluation and treatment of high subtrochanteric femur fractures. Am J Orthop (Belle Mead NJ) [Internet]. 2000 Sep [cited 2017 Oct 14];29(9 Suppl):27–33. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11011777

54. Jiang L-S, Shen L, Dai L-Y. Intramedullary Fixation of Subtrochanteric Fractures with Long Proximal Femoral Nail or Long Gamma Nail: Technical Notes and Preliminary Results. 2007 [cited 2017 Oct 14];36(10). Available from: https://pdfs.semanticscholar.org/92d9/f5f296b16f55d1c995893c158bcca952e90d.pdf

55. Lee WT, Murphy D, Kagda FHY, Thambiah J. Proximal femoral locking compression plate for proximal femoral fractures. J Orthop Surg (Hong Kong) [Internet]. 2014;22(3):287–93. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25550004

56. Chalise PK, Mishra AK, Shah SB, Adhikari V, Singh RP. Outcome of pertrochantric fracture of the femur treated with proximal femoral locking compression plate. Nepal Med Coll J. 2012;14(4):324–7.

57. Reddy PK, Pradeep G. Proximal femoral nailing improves

functional and radiological outcomes of subtrochanteric fractures of femur -our experience. IJSAR Int J Sci Appl Res [Internet]. 2015 [cited 2017 Oct 13];2(3):50–4. Available from: http://www.ijsar.in/Download/Papers/March 2015/10.pdf

58. Streubel PN, Moustoukas M, Obremskey WT. Locked plating versus cephalomedullary nailing of unstable intertrochanteric femur fractures. Vol. 26, European Journal of Orthopaedic Surgery and Traumatology. 2016. p. 385–90.

59. Use of an Interlocked Cephalomedullary Nail for Subtrochante... : Clinical Orthopaedics and Related Research [Internet]. [cited 2017 Oct 14]. Available from: http://journals.lww.com/corr/Abstract/1998/03000/Use_of_an_Interlocked_Cephalomedullary_Nail_for.16.aspx

60. Wang WY, Yang TF, Fang Y, Lei MM, Wang GL, Liu L. Treatment of subtrochanteric femoral fracture with long proximal femoral nail antirotation. Chin J Traumatol [Internet]. 2010 Feb 1 [cited 2017 Oct 14];13(1):37–41. Available from: http://www.sciencedirect.com/science/article/pii/S1008127510600077

61. Blokhuis TJ, Baltov A, Iotov A. Formulations and delivery vehicles for bone morphogenetic proteins: latest advances and future

directions. Injury [Internet]. 2009 Dec 1 [cited 2017 Oct 14];40 Suppl 3:S8-11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20082796

62. Asif N, Ahmad S, Qureshi OA, Jilani LZ, Hamesh T, Jameel T. Unstable intertrochanteric fracture fixation – Is proximal femoral locked compression plate better than dynamic hip screw. J Clin Diagnostic Res. 2016;10(1):RC09-RC13.

63. Jiang LS, Shen L, Dai LY. Intramedullary fixation of subtrochanteric fractures with long proximal femoral nail or long gamma nail: Technical notes and preliminary results. Ann Acad Med Singapore. 2007;36(10):821–6.

64. Singh AK, Narsaria N, G R A, Srivastava V. Treatment of Unstable Trochanteric Femur Fractures: Proximal Femur Nail Versus Proximal Femur Locking Compression Plate. Am J Orthop (Belle Mead NJ) [Internet]. [cited 2017 Oct 14];46(2):E116–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28437506

65. Mittal S, Bhuyan S, Ailani R, Tontanahal S, Mittal CS. Comparison of the functional and radiological outcomes of unstable intertrochanteric fractures treated with dynamic hip screw and proximal femoral nail-A prospective randomized controlled study. Int J Orthop Sci IJOS [Internet]. 2017 [cited 2017 Oct 14];3(33):81–5. Available from:

www.orthopaper.com

66. Mandal S, Kumar N, Banerjee U, Roy D, Mandal S. Comparative Analysis of the Results of Trochanteric Femoral Nail and Dynamic Hip Screw in Treatment of Comminuted Unstable Trochanteric Fractures – a Prospective Randomised Controlled Trial on Indian Population. Orig Res J Indian Orthop Rheumatol Assoc [Internet]. [cited 2017 Oct 14];1(1):12–9. Available from: https://www.innovativepublication.com/admin/uploaded_files/JIORA_1(1)_12-19.pdf

67. TREATMENT OF EXTRACAPSULAR HIP FRACTURES WITH THE PROXIMAL FEMORAL NAIL. [cited 2017 Oct 14]; Available from: http://www.orthodoctor.gr/wp-content/uploads/2014/03/pfn-arthro.pdf

68. Khan IA, Bhatti A, Power D, Qureshi S. Orthopaedic proceedings. [Internet]. Vol. 86–B, Orthopaedic Proceedings. Orthopaedic Proceedings; 2004 [cited 2017 Oct 14]. 225-226 p. Available from: http://bjjprocs.boneandjoint.org.uk/content/86-B/SUPP_III/225.6.short

69. Treatment of Reverse Oblique and Transverse Intertrochanteri... : JBJS [Internet]. [cited 2017 Oct 14]. Available from: http://journals.lww.com/jbjsjournal/subjects/Hip/Fulltext/2002/03000/Tre

atment_of_Reverse_Oblique_and_Transverse.7.aspx

70. Biological fixation of comminuted subtrochanteric fractures with proximal femur locking compression plate. Injury [Internet]. 2013 Feb 1 [cited 2017 Oct 14];44(2):226–31. Available from: http://www.sciencedirect.com/science/article/pii/S002013831200486X

71. Yadkikar S, Yadkikar S V, Yadkikar VS, Prasad D V, Marawar A. Prospective study of proximal femoral nail in management of trochanteric and subtrochanteric fractures of femur. Int J Biomed Adv Res [Internet]. 2015 Apr 21 [cited 2017 Oct 14];6(4):349–54. Available from: http://www.ssjournals.com/index.php/ijbar/article/view/1934

72. Singh Jaura G, Gosal G. Management of Subtrochanteric Fracture Femur by Proximal Femoral Nail. Int J Sci Res ISSN (Online Index Copernicus Value Impact Factor [Internet]. 2013 [cited 2017 Oct 14];14611(11):2319–7064. Available from: www.ijsr.net

73. Ozkan K, Türkmen İ, Sahin A, Yildiz Y, Erturk S, Soylemez MS. A biomechanical comparison of proximal femoral nails and locking proximal anatomic femoral plates in femoral fracture fixation: A study on synthetic bones. Indian J Orthop [Internet]. 2015 [cited 2017 Oct 14];49(3):347–51. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26015637

74. Gowda PM. Study of Management of Subtrochanteric fractures of the femur in Adults using Proximal Femoral Nails Indian Journal of Basic and Applied Medical. Indian J Basic Appl Med Res. 2014;3(2):444–7.

75. Oh C-W, Kim J-J, Byun Y-S, Oh J-K, Kim J-W, Kim S-Y, et al. Minimally invasive plate osteosynthesis of subtrochanteric femur fractures with a locking plate: a prospective series of 20 fractures. Arch Orthop Trauma Surg [Internet]. 2009 Dec 24 [cited 2017 Oct 14];129(12):1659–65. Available from: http://link.springer.com/10.1007/s00402-009-0815-y

76. Mm H, Qs A, Fh Q, Mti N. Evaluation of the Outcome of Proximal Femoral Locking Compression Plate for the Treatment of Comminuted Trochanteric and Subtrochanteric Femoral Fractures in Lateral Decubitus Approach Without Peroperative Image Intensifier. 2008;

77. Kanthimathi B, Orth DNB, Narayanan VL, Orth MS. Early Complications in Proximal Femoral Nailing Done for Treatment of Subtrochanteric Fractures. 2012;6(1):25–9.

78. Streubel PN, Moustoukas MJ, Obremskey WT. Mechanical Failure After Locking Plate Fixation of Unstable Intertrochanteric Femur Fractures. J Orthop Trauma [Internet]. 2013 Jan [cited 2017 Oct 14];27(1):22–8. Available from:

http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005131-201301000-00008

79. Gadegone WM, Salphale YS. Proximal femoral nail - an analysis of 100 cases of proximal femoral fractures with an average follow up of 1 year. Int Orthop [Internet]. 2007 Jun [cited 2017 Oct 14];31(3):403–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16823585

80. Codesido P, Mejía A, Riego J, Ojeda-Thies C. Subtrochanteric fractures in elderly people treated with intramedullary fixation: quality of life and complications following open reduction and cerclage wiring versus closed reduction. Arch Orthop Trauma Surg [Internet]. 2017 Aug 29 [cited 2017 Oct 14];137(8):1077–85. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28555367

81. Ekström W, Miedel R, Ponzer S, Hedström M, Samnegård E, Tidermark J. Quality of Life After a Stable Trochanteric Fracture-A Prospective Cohort Study on 148 Patients. J Orthop Trauma [Internet]. 2009 Jan [cited 2017 Oct 14];23(1):39–44. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005131-200901000-00006

82. Koyuncu Ş, Altay T, Kayalı C, Ozan F, Yamak K. Mechanical failures after fixation with proximal femoral nail and risk factors. Clin

Interv Aging [Internet]. 2015 [cited 2017 Oct 15];10:1959–65. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26719682

83. Wirtz C, Abbassi F, Evangelopoulos DS, Kohl S, Siebenrock KA, Krüger A. High failure rate of trochanteric fracture osteosynthesis with proximal femoral locking compression plate. Injury [Internet]. 2013 Jun [cited 2017 Oct 14];44(6):751–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23522837

84. Reverse Obliquity Fractures of the Intertrochanteric Region... : JBJS [Internet]. [cited 2017 Oct 14]. Available from: http://journals.lww.com/jbjsjournal/subjects/Hip/Abstract/2001/05000/Reverse_Obliquity_Fractures_of_the.1.aspx

**HARRIS HIP SCORE:**

**PAIN:**
None or ignores it (44)
Slight, occasional, no compromise in activities (40)
Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
Moderate pain, tolerable but makes concessions to pain; some limitation of ordinary activity or work; may require occasional pain medicine stronger than aspirin (20)
Marked pain, serious limitation of activities (10)
Totally disabled, crippled, pain in bed, bedridden (0).

**LIMP:**
None(11)
Slight (8)
Moderate (5)
Severe (0)

**SUPPORT:**
None (11)
Cane for long walks (7)
Cane full time(5)
Crutch(4)
2 Canes(2)
2 Crutches(1)
Unable to walk(0)

**DISTANCE WALKED:**
Unlimited (11)
Six blocks (8)
Two or three blocks (5)
Indoors only (2)
Bed and chair (0)

**STAIRS**:
Normally without using a railing (4)
Normally using a railing (2)
In any manner (1)
Unable to do stairs (0)

**PUT ON SHOES AND SOCKS**:
With ease (4)

With difficulty (2)
Unable(0)

**SITTING:**
Any chair 1 hour(5)
High Chair(3)
Unable to sit half an hour any chair(0)

**PUBLIC TRANSPORTATION:**
Able to enter public transport(1)
Unable to use public transport (0)

**TOTAL HARRIS HIP SCORE:**

## PROFORMA

1. Name of the patient :
2. Age / Sex :
3. I.P. no. :
4. Occupation :
5. Address/ Phone no:
6. Date of admission :
7. Interval between injury and admission :
8. Mode of Injury :
9. Side of injury :
10. Associated injuries :
11. Associated medical co morbidities :
12. X – ray pelvis with both Hip and Femur :
13. Russel and Taylor classification :
14. Type of anaesthetia :
15. Method of reduction :
16. Type of implant used :
17. Duration of surgery :
18. Intra operative complication :
19. Intra-operative blood loss:
20. Post operative treatment :
    - Physiotheraphy :
    - Weight bearing :
21. Blood transfusion :
22. Drain removal :
23. Date of discharge :
24. Suture removal :
25. Post operative complication :
26. Clinical assessment during follow up :
27. Fracture union :
28. Harris hip score :

# MASTER CHART

| S.No | NAME | AGE | SEX | IP NO | MODE OF INJURY | CLASSIFICATION | SIDE | IMPLANT | UNION TIME | HHS | INFECTION | SHORTENING | SCREW BREAKAGE | VARUS COLLAPSE | IMPLANT FAILURE | LURCHING | OPERATING TIME | BLOOD LOSS | FOLLOW UP(MONTHS) | REDUCTION | BONE GRAFTING | ASSOCIATED INJURIES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MOHAMMD ISMAIL | 62 | M | 74563 | ACC FALL | RT IB | LT | LONG PFN | 16 WEEKS | E 91 | NIL | NIL | NIL | NIL | NIL | ABSENT | 75 MIN | 90 ML | 11 MONTHS | OPEN | PRIMARY | NIL |
| 2 | ARUMUGAM | 29 | M | 5348 | RTA | RT IIB | RT | LONG PFN | 16 WEEKS | G 87 | NIL | NIL | NIL | NIL | NIL | ABSENT | 80 MIN | 70 ML | 9 MONTHS | CLOSED | NIL | NIL |
| 3 | SENTHILKUMAR | 37 | M | 40985 | RTA | RT IA | LT | LONG PFN | NON UNION | F 78 | NIL | 1CM | NIL | NIL | NIL | PRESENT | 90MIN | 1OOML | 13 MONTHS | OPEN | NIL | NIL |
| 4 | MADHU | 67 | M | 78659 | RTA | RT IB | LT | PFLCP | MALUNION | G 88 | NIL | NIL | NIL | NIL | NIL | ABSENT | 1OO MIN | 150 ML | 15 MONTHS | OPEN | NIL | NIL |
| 5 | GNANAMANI | 65 | F | 67543 | ACC FALL | RT IIB | LT | PFLCP | 16 WEEKS | P 67 | NIL | 2CM | SCREW BREAKAGE | PRESENT | SCREW LOOSENING ,PLATE PULLOUT | PRESENT | 120 MIN | 200ML | 8 MONTHS | OPEN | NIL | NIL |
| 6 | SUBRAMANI | 75 | M | 563342 | ACC FALL | RT IA | RT | PFLCP | 24 WEEKS | F 75 | NIL | NIL | NIL | NIL | NIL | ABSENT | 80 MIN | 150ML | 11 MONTHS | OPEN | NIL | Chestwall injury |
| 7 | SASIKUMAR | 38 | M | 8765 | RTA | RTIA | LT | LONG PFN | 16 WEEKS | G 88 | NIL | NIL | NIL | NIL | NIL | ABSENT | 95MIN | 75ML | 12 MONTHS | OPEN | NIL | NIL |
| 8 | SUNDARRAJ | 47 | M | 5674 | RTA | RT IB | RT | PFLCP | 16 WEEKS | E 93 | NIL | 1CM | NIL | NIL | NIL | ABSENT | 120 MIN | 150 ML | 8 MONTHS | OPEN | PRIMARY | NIL |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | SARAVANAN | 33 | M | 67854 | RTA | IB | LT | PFLCP | 16 WEEKS | G 83 | NIL | NIL | NIL | NIL | NIL | ABSENT | 100 MIN | 100 ML | 7 MONTHS | OPEN | NIL | NIL |
| 10 | SUBRAMANI | 27 | M | 53002 | RTA | RTIIB | LT | LONG PFN | 16 WEEKS | E 95 | NIL | NIL | NIL | NIL | NIL | ABSENT | 70 MIN | 75ML | 12 MONTHS | CLOSED | NIL | |
| 11 | AMMASI | 75 | M | 71006 | ACC FALL | RTIB | LT | LONG PFN | 20 WEEKS | F 71 | NIL | 1CM | NIL | NIL | NAIL BREAKAGE | PRESENT | 100 MIN | 85ML | 12 MONTHS | OPEN | NIL | NIL |
| 12 | SATISH | 37 | M | 78534 | ACC FALL | RTIB | LT | LONG PFN | 12 WEEKS | E 93 | NIL | NIL | NIL | NIL | NIL | ABSENT | 60 MIN | 50 ML | 8 MONTHS | CLOSED | NIL | NIL |
| 13 | SRIDHAR | 45 | M | 4356 | RTA | RTIB | LT | LONG PFN | 16 WEEKS | E 95 | NIL | NIL | NIL | NIL | NIL | ABSENT | 80 MIN | 75 ML | 7 MONTHS | OPEN | PRIMARY | NIL |
| 14 | PERUMAL | 35 | M | 65908 | RTA | RTIB | RT | PFLCP | 20 WEEKS | G 83 | NIL | NIL | NIL | NIL | NIL | ABSENT | 120 MIN | 125 ML | 7 MONTHS | OPEN | NIL | DM |
| 15 | PALANISAMY | 68 | M | 62314 | RTA | RTIB | LT | PFLCP | NON UNION | P65 | NIL | 3CM | NIL | PRESENT | PLATE BREAKAGE | PRESENT | 100MIN | 150 ML | 22 MONTHS | OPEN | NIL | SHT |
| 16 | KRISHNAN | 65 | M | 56437 | ACC FALL | RTIB | RT | PFLCP | NON UNION | P 67 | NIL | 2CM | SCREW BREAKAGE | PRESENT | PLATE PULL OUT | PRESENT | 110 MIN | 125 ML | 20 MONTHS | OPEN | NIL | NIL |
| 17 | THOWLATH KHAN | 63 | M | 69087 | RTA | RTIA | RT | LONG PFN | 16 WEEKS | G 88 | NIL | 1CM | NIL | NIL | NIL | ABSENT | 60 MIN | 75 ML | 7 MONTHS | CLOSED | NIL | NIL |
| 18 | PERIYAMMAL | 65 | F | 65743 | ACC FALL | RTIB | LT | PFLCP | 20 WEEKS | G 85 | NIL | NIL | NIL | NIL | NIL | ABSENT | 9O MIN | 175ML | 10 MONTHS | OPEN | NIL | DM |
| 19 | THANGAM | 55 | M | 8976 | RTA | RTIB | RT | PFLCP | 16 WEEKS | G 84 | NIL | NIL | NIL | NIL | NIL | ABSENT | 1OO MIN | 200 ML | 8 MONTHS | OPEN | PRIMARY | NIL |
| 20 | SANKARCHETTY | 59 | M | 68443 | ACC FALL | RT1B | RT | LONG PFN | 12WEEKS | G 87 | NIL | NIL | PRESENT | NIL | SCREW BREAK AT TIP | ABSENT | 90MIN | 85ML | 7MONTHS | CLOSED | NIL | NIL |